



**Uttar Pradesh Rajarshi  
Tandon Open University**

# MFN-106

## ADVANCE CLINICAL AND THERAPEUTIC NUTRITION

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**BLOCK-1**  
**SCREENING AND ASSESSMENT OF NUTRITIONAL**  
**STATUS & DIET, NUTRIENT AND DRUG**  
**INTERACTION**



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# UNIT-1 : Nutritional Screening and Assessment of Nutritional Status of Hospitalized and Outdoor Patients

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## STRUCTURE

- 1.1 Introduction
- 1.2 Identification of High Risk Patient
  - 1.2.1 Factors that contribute to high-risk status
  - 1.2.2 Methods for identifying high-risk patients
  - 1.2.3 Benefits of identifying high-risk patients
- 1.3 Assessment of Patient Needs Based on Interpretation of Patient Data
  - 1.3.1 Clinical Assessment
  - 1.3.2 Biochemical Assessment
  - 1.3.3 Biophysical Assessment
  - 1.3.4 Personal Assessment
- 1.4 Let Us Sum Up
- 1.5 Check Your Progress Exercises

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## 1.1 Introduction

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Nutritional screening and assessment are crucial for identifying and addressing malnutrition in both hospitalized and outpatient populations. Screening is a rapid process to identify individuals at risk, while assessment provides a more detailed evaluation of their nutritional status. This helps healthcare professionals develop appropriate nutrition plans and interventions to improve patient outcomes.

Nutritional screening and assessment are essential components of healthcare, helping to identify and address malnutrition in both hospitalized and outpatient settings. This proactive approach can lead to improved patient outcomes and reduced healthcare costs. In this unit we will study about Identification of high risk patients and data interpretation.

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## 1.2 Identification of High Risk Patient

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High-risk patients are individuals with conditions that increase their vulnerability to poor health outcomes or complications, often due to complex medical histories, functional limitations, or social factors. Identifying these patients allows for timely interventions and personalized care plans to improve outcomes.

### 1.2.1 Factors that contribute to high-risk status

- **Complex medical conditions:** Patients with multiple chronic diseases, like diabetes, heart disease, and chronic lung disease, are often considered high-risk.
- **Functional limitations:** Individuals with disabilities that impact their ability to perform daily activities or self-care are also at higher risk.
- **Social determinants of health:** Factors like poverty, lack of access to healthcare, and inadequate housing can significantly impact health outcomes and increase risk.

- **Psychological and behavioral factors:** Mental health conditions, substance abuse, and behavioral issues can also contribute to a higher risk profile.
- **Specific medical conditions:** Conditions like cancer (especially during treatment), solid organ transplants, and severe immune suppression can make individuals high-risk.

### 1.2.2 Methods for identifying high-risk patients

- **Data analysis and predictive modeling:** Using electronic health records (EHRs) and claims data to identify patterns and predict which patients are likely to experience adverse outcomes.
- **Risk stratification tools:** Employing validated scoring systems or algorithms to categorize patients based on their risk levels.
- **Early warning scores:** Utilizing scores like NEWS (National Early Warning Score) to assess the severity of illness and predict clinical deterioration.
- **Patient-reported outcomes:** Incorporating patient-reported measures of functional status, pain, and other relevant factors into risk assessment.
- **Qualitative assessment:** Conducting in-depth interviews with patients and their families to gather information about their social, psychological, and behavioral circumstances.

### 1.2.3 Benefits of identifying high-risk patients

- **Improved outcomes:** Targeted interventions and personalized care can lead to better health outcomes and reduced mortality.
- **Reduced healthcare costs:** Proactive management of high-risk patients can help prevent unnecessary hospitalizations and emergency department visits.
- **Enhanced patient experience:** Understanding a patient's individual needs and vulnerabilities allows for more tailored and compassionate care.
- **Better resource allocation:** Prioritizing care for high-risk individuals ensures that scarce resources are used effectively.

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## 1.3 Assessment of Patient Needs Based on Interpretation of Patient Data

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Assessing patient needs based on interpreting data is a crucial step in healthcare, involving collecting and analyzing both subjective and objective information to identify the patient's current and future care requirements. This process helps in understanding the patient's physiological status and prioritizing interventions, leading to better outcomes. Interpreting patient biochemical assessment data involves understanding how laboratory results relate to nutritional status, disease diagnosis, and monitoring treatment progress. It requires considering factors like reference ranges, patient-specific characteristics, and the potential impact of medications or other health conditions.

### 1.3.1 Clinical Assessment

**Collecting Data:** Clinicians gather information from multiple sources, including:

- **Subjective data:** Patient's report of symptoms, history, and experiences.
- **Objective data:** Physical examination findings, vital signs, and laboratory results.
- **Medical history:** Past illnesses, surgeries, allergies, and medications.
- **Diagnostic tests:** Imaging, blood tests, and other investigations.

- **Patient experience data:** Information about how the patient feels, functions, and survives related to their condition or treatment.

**Analyzing and Interpreting Data:** This involves:

- **Identifying patterns and relationships:** Recognizing connections between different pieces of information.
- **Formulating hypotheses:** Developing potential explanations for the patient's condition.
- **Evaluating the evidence:** Considering the reliability and validity of the data.
- **Making clinical judgments:** Using the interpretation to guide decisions about treatment, monitoring, and further investigation.

**Applying the Interpretation:** The findings are used to:

- **Develop a diagnosis:** Identifying the underlying cause of the patient's problems.
- **Plan treatment:** Choosing the most appropriate interventions based on the assessment.
- **Monitor the patient's progress:** Tracking their response to treatment and making adjustments as needed.
- **Provide patient education:** Helping the patient understand their condition and treatment plan.

**Example:** A patient reports chest pain, which is a subjective finding. A physical exam reveals elevated heart rate and blood pressure, which are objective findings. An electrocardiogram (ECG) shows signs of heart damage, which is a diagnostic test result. Interpreting these findings together could lead to a diagnosis of a heart attack, prompting immediate intervention.

### 1.3.2 Biochemical Assessment

**Understanding Biochemical Markers:**

- **Nutritional Status:** Biochemical tests can reveal imbalances in nutrient levels, providing insights into potential deficiencies or excesses.
- **Disease Diagnosis:** Elevated or decreased levels of specific biochemical markers can be indicative of various diseases or conditions.
- **Treatment Monitoring:** Regular biochemical assessments can help track the effectiveness of interventions and adjust treatment plans as needed.

**Interpreting Results:**

- **Reference Ranges:** Compare the patient's results to established reference ranges, which are based on healthy populations.
- **Patient-Specific Factors:** Consider factors like age, sex, ethnicity, and other health conditions that can influence biochemical levels.
- **Clinical Context:** Integrate the biochemical findings with the patient's medical history, physical examination, and other diagnostic results.

**Key Considerations:**

- **Reference Change Value (RCV):** In serial testing, RCV helps determine if a result has changed significantly, taking into account analytical and biological variations.

- **Reference Change Factor (RCF):** RCF is used to define upper and lower limits in repetitive measurements, helping to account for laboratory variations.
- **Interpreting Abnormalities:** Identify the potential causes of abnormal results, considering factors like disease, medications, or errors in the test procedure.

#### Common Biochemical Tests and Their Significance:

- **Blood Glucose:** Used to assess carbohydrate metabolism and diagnose conditions like diabetes.
- **Lipid Profile:** Evaluates cholesterol and triglycerides, providing insights into cardiovascular risk.
- **Hemoglobin:** Indicates oxygen-carrying capacity of the blood and can be used to diagnose anemia.
- **Serum Albumin:** Reflects liver function and protein status, but can be affected by hydration and other factors.
- **Micronutrients:** Assesses levels of vitamins and minerals, providing insights into potential deficiencies.

#### 1.3.3 Biophysical Assessment

A patient's biophysical assessment, particularly in the context of foetal well-being, involves evaluating several key parameters to assess overall health and risk of complications. The interpretation of these findings relies on a combination of observation and numerical scoring, ultimately guiding clinical decisions. A biophysical profile (BPP) score of 8 to 10 is generally considered normal, indicating a well-oxygenated foetus and no immediate need for intervention. A score of 6 may suggest potential problems, warranting further evaluation or repeat testing, and a score of 4 or less often indicates the need for immediate delivery or other interventions.

- **Foetal Breathing Movements:** The presence of at least one episode of breathing lasting 30 seconds within 30 minutes is considered normal.
- **Foetal Movements:** Three or more discrete body movements within 30 minutes suggest normal activity.
- **Foetal Tone:** At least one episode of flexion and extension of a limb within 30 minutes indicates normal muscle tone.
- **Amniotic Fluid Volume:** A pocket of fluid measuring 2 cm in depth or greater is considered normal.
- **Foetal Heart Rate (via NST):** Two or more accelerations of at least 15 beats per minute lasting 15 seconds within 20 minutes indicates a reactive non-stress test (NST), which is considered a positive sign of foetal well-being.

**Scoring and Interpretation:** Each parameter is typically scored on a scale of 0 to 2, with a total BPP score ranging from 0 to 10.

- **Normal Score (8-10):** Indicates a healthy foetus with no significant concerns.
- **Borderline Score (6):** Requires close observation and potentially further evaluation, such as repeat testing or more detailed ultrasound.
- **Abnormal Score (4 or Below):** May indicate foetal distress and may warrant immediate

interventions like delivery or further testing.

### 1.3.4 Personal Assessment

Data interpretation in patient personal assessment involves understanding and explaining the meaning of gathered information to identify the patient's individual needs and health status. This includes both subjective (patient's perspective) and objective (observable data) information. The goal is to identify potential health issues, support informed clinical decisions, and tailor care plans to the patient's specific circumstances.

#### Steps in Data Interpretation:

- **Data Collection:**Gather both subjective (patient's reports) and objective (clinical findings, test results) data.
- **Data Analysis:**Analyze the collected data to identify patterns, trends, and anomalies.
- **Interpretation:**Explain the meaning of the findings in the context of the patient's condition and the larger clinical picture.
- **Drawing Conclusions:**Formulate a diagnosis or identify areas for further investigation based on the interpretation of the data.
- **Developing Recommendations:**Suggest a plan of care, including treatment options, monitoring strategies, and patient education.

#### Factors to Consider:

**Patient's Medical History:**Understanding previous illnesses, surgeries, medications, and family history can provide valuable context.

**Social History:**Factors like socioeconomic status, lifestyle, and support systems can influence health outcomes.

**Cultural Factors:**Recognizing cultural beliefs and values can help tailor communication and treatment approaches.

**Patient's Self-Assessment:**Involving the patient in the assessment process can provide valuable subjective insights.

**Clinical Data:**Reviewing vital signs, lab results, imaging studies, and other clinical findings can help confirm or refute subjective reports.

#### Tools for Interpretation:

- **SOAP Notes:** A commonly used method for recording and interpreting patient data.
- **Patient-Reported Outcome (PRO) Scores:** Measures used to assess patient experiences and outcomes.
- **Needs Assessments:** Tools to identify unmet needs and areas for improvement in patient care.
- **Statistical Analysis:** Used to analyze large datasets and identify patterns or trends.

#### Benefits of Data Interpretation:

- **Accurate Diagnosis:**Helps healthcare professionals make informed decisions about diagnoses and treatment plans.

- **Personalized Care:** Allows for tailoring treatment and interventions to the specific needs of each patient.
- **Improved Outcomes:** By understanding the patient's situation, healthcare professionals can better manage conditions and improve outcomes.
- **Enhanced Communication:** Facilitates clearer communication between healthcare providers and patients.

#### **Data Collection:**

- **Subjective Data:** This includes information gathered directly from the patient, such as their experiences, feelings, and symptoms.
- **Objective Data:** This involves observations and measurements, like vital signs (heart rate, respiratory rate, temperature, blood pressure), physical examination findings, and laboratory results.

#### **Interpretation:**

- Nurses and healthcare professionals analyze the collected data to identify patterns and trends.
- This interpretation helps in recognizing normal and abnormal patient physiology.
- It also aids in determining the patient's current and potential future care needs.

#### **Prioritization:**

- The assessment process enables healthcare providers to prioritize interventions based on the patient's immediate needs and the severity of their condition.
- This ensures that resources are allocated effectively and that the most critical care is provided first.

#### **Benefits of Accurate Assessment:**

- **Improved Treatment:** By accurately assessing patient needs, healthcare professionals can develop tailored treatment plans that are more likely to be effective.
- **Enhanced Outcomes:** Effective assessment helps in identifying and addressing potential problems early on, leading to better patient outcomes and reduced complications.
- **Increased Patient Safety:** By understanding the patient's individual needs and risks, healthcare providers can implement appropriate safety measures to prevent harm.

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## **1.4 Let Us Sum Up**

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Data interpretation of patient information involves understanding, organizing, and drawing meaningful conclusions from patient data. This process helps improve healthcare efficiency, personalize treatment, and ultimately enhance patient outcomes. It's a crucial aspect of modern healthcare, particularly with the rise of data analytics and machine learning. In conclusion, data interpretation is a critical process in healthcare that enables providers to make informed decisions, improve patient outcomes, and enhance the overall quality of care. With the increasing availability of data and advancements in technology, data interpretation is becoming an increasingly important tool for modern healthcare.

## Examples of Data Interpretation in Healthcare

- **Predictive Analytics:** Using data to predict which patients are at high risk for a specific disease or complication, allowing for early intervention.
- **Prescriptive Analytics:** Helping doctors choose the most effective treatment options for a patient based on their unique medical history and genetic profile.
- **Patient Experience Analysis:** Analyzing patient feedback to identify areas for improvement in the patient journey, such as wait times or communication.

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## 1.5 Answers to Check Your Progress Exercises

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### 1.5.1 What are the Methods for identifying high-risk patients?

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### 1.5.2 Explain the importance of Benefits of identifying high-risk patients?

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### 1.5.3 Elaborate Benefits of identifying high-risk patients?

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## UNIT-2 : NEW TRENDS IN DELIVERY

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### STRUCTURE

- 2.1 Introduction
- 2.2 Delivery
  - 2.2.1 Nutritional requirements during Pregnancy
  - 2.2.2 Nutritional care after delivery
- 2.3 Dietary Counseling
- 2.4 Let Us Sum Up
- 2.5 Check Your Progress Exercises

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### 2.1 Introduction

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Some of the best practices you can do when pregnant is to eat healthily. As your pregnancy continues, higher demands on your organs can be managed with good nutrition. The objective is to strike a balance between keeping a healthy weight and consuming enough nutrients to promote the growth of your foetus. The common cliché suggests that pregnant women "eat for two," but we now know that eating twice as much food as usual while pregnant is harmful. Instead of "eating for two," consider eating twice as healthily

Starting in the subsequent trimester (and a little more in the third), you require an additional 340 calories / day if you have become pregnant with one foetus. That is approximately the number of calories in a glass of skimmed milk and a half-sandwich. Women should eat an additional 600 calories per day for twins and 900 calories per day for triplets when they are pregnant.

It's challenging to predict everything that will occur before you give birth. The majority of people have an idea of how they want their labour and delivery to go. It's a good idea to be aware of the various delivery techniques prenatal care providers employ. Delivery methods include:

- Vaginal birth.
- Assisted vaginal birth with forceps or a hoover.
- Birth through caesarean section.
- Vaginal birth after caesarean, or VBAC.

The most crucial factors to take into account when trying to stay healthy and active during pregnancy are your nutritional needs. During this time, a woman's body experiences fast change. They must therefore give the body full support if they are to be consistent with the modifications. Women must therefore follow an appropriate diet and know what is best for them in order to achieve this. This part is divided into two categories: the time of the woman's encounter with the healthcare professional and her lactation status (whether or not she is nursing). The mother is the main subject, not the child. In a perfect world, the mother would be contacted when she is in the hospital recovering from childbirth, within days after she is released (by phone and home visit), during early paediatric appointments, and during the visit approximately four to six weeks after childbirth. In order to refill the store of nutrients and maintain health, it is highly beneficial for all women, egalitarian to whether they are breastfeeding.

In addition, due to the overall development of both the mother and the unborn child, consuming nutrition is essential throughout pregnancy. This will be thoroughly covered in the following section.

## OBJECTIVES:-

1. Students will be able to gain knowledge about different delivery types & conditions.
2. Students will learn about the nutritional requirement during pregnancy & after delivery.

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## 2.2 Delivery

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In India, confinement time guidelines and postpartum nutrition restrictions are typical. These rules to obey terrify expectant mothers more than having birth itself. The guidelines and diet at this time are crucial because by adhering to the diet, which includes Indian foods eaten after birth, the mother not only recovers more rapidly but also increases the amount of breast milk she produces.

Healthy eating is vital for the well-being of the mother and the unborn child before, during, and after pregnancy. Your body is healing now that it has worked really hard. Therefore, you must get some rest and replenish all of your depleted energy. It is thought that a woman's appetite greatly increases after giving birth, especially if she is lactating.

Since the first 40 days following delivery are crucial in the postnatal period, there are several precautions and practices to be observed. An unusual experience is labor. Sometimes it only lasts a few hours. Other times, labor puts a mother's mental and bodily endurance to the test. Prior to giving birth, you won't be able to predict how labor and delivery will go. However, by comprehending the regular flow of events, you can get ready. The most common and safest method of childbirth is vaginal birth. In the United States, 68% of births are carried out vaginally. A vaginal delivery is advised by the majority of medical institutions and obstetricians unless a C-section is necessary for medical reasons. Your baby enters the world through your birth canal or vagina during a vaginal delivery. Due to the fact that it offers the lowest risk (which is, in most circumstances), it is the most popular and frequent method of giving birth. The most frequent time for a vaginal delivery is between week 37 and 42 of gestation. There are three stages to a vaginal delivery: labor, birth, and placenta delivery.

Among the advantages of the vaginal birth are:

- Quicker recovery.
- Safest for both the mother and the unborn child.
- Lower infection rates.
- Infants have an immune system that is better and are less likely to experience respiratory issues.
- Most of the time, lactation and breastfeed are simpler.

The delivery through the vagina can happen naturally or be forced:

- **Spontaneous vaginal birth:** a caesarean section that occurs naturally and without the use of medications to speed up labour. It is preferable to give birth naturally around 40 weeks of pregnancy.
- **Drugs or other methods** can induce labour and shorten or open your cervical cavity so that the baby can be delivered vaginally. When a pregnant individual has a medical issue or is past due, pregnancy care experts frequently advise bringing on labour. Typically, the medication oxytocin in its synthetic form, Pitocin®, is used to induce labour.
- Depending on the circumstances that develop during labour, your obstetrician will advise a different course of action. The following assisted delivery techniques are possible:

- **Forceps delivery:** An obstetrician will use forceps, which resemble surgical tongs, to guide your baby's head out of the womb's birth canal.
- **Vacuum extraction delivery:** Your obstetrician places a little suction cup on your baby's head during a vacuum extraction. While you push, the cup is connected to a pump which pulls on your child. The decision between a vacuum extraction as well as forceps birth frequently comes down to your obstetrician's experience because both procedures have perks and downsides that are comparable.

Wellbeing, particularly before, during, and after childbirth. If women are free from every type of malnutrition when they become pregnant, if they have nourishing diets, if they have access to necessary nutrition services, and if they adopt ideal dietary practises during pregnancy, they are more likely to have a healthy pregnancy and are now less likely to experience life-threatening complications. Additionally, new-borns of adequately fed mothers are more probable to have a healthy birthweight and grow and develop normally in infancy. Following delivery, women's dietary needs must be met, especially those of breastfeeding moms, in order to replenish their body's nutritious resources.

### **Vaginal Birth**

Vaginal delivery, often known as a natural birth, occurs when a baby is given through the womb's birth canal. Most medical professionals will advocate for it whenever it is feasible and will always choose to forgo having a caesarean section performed. Vaginal births are strongly advised for mothers who intend to have numerous children. The operation is known as an episiotomy when it involves making an incision beneath the anal region.

### **C-section (Caesarean section)**

A surgical wound is created in the mother's abdomen and uterus during a C-section, after which the baby is delivered. A C-section may be scheduled, as many women choose to do, or it can be carried out if the pregnancy requires it. Because problems might occur during labour and an emergency C-section may make birth much safer for both mother and child, it can also happen unexpectedly.

### **An Assisted Vaginal Birth**

Vaginal births are the most typical kind of birth. Methods of assisted delivery are frequently utilised when necessary. Although labour is a simple and basic process, it occasionally necessitates the aid of additional medical personnel. From the use of medications to urgent delivery techniques, aid is available.

### **Water supply**

In a water birth, the mother experiences either one or all of childbirth's stages in a mobile tub that resembles a hot tub. When a mother is underwater, the baby can still be delivered. Even better, the woman can exit the water and give birth to the child in another position. Because giving birth in the water can be more soothing and less painful, women prefer to do so.

### **Lamaze Method**

Natural delivery is in line with the Lamaze method, which is renowned for its method of controlled breathing. The method also includes a variety of comfort measures that can be applied during childbirth. The breathing exercises used promote relaxation and lessen pain perception.

### **Bradley Approach**

The Bradley Method emphasises preparing moms for partner-assisted natural delivery. The focus is on preparing for an unmediated, vaginal birth without assistance. The method is presented over the course of 12 weeks with the use of a workbook and extra assistance from relatives and close friends. The method covers nutrition and other natural health topics in addition to teaching techniques for minimising pain during vaginal birth.

## **Hypnosis**

Hypnobirthing sessions teach calm based on self-hypnosis, visualisations, and breathing methods to generate a state of relaxation that is free of the resistance caused by fear. They are more of a philosophy than a technique. The technique encourages a woman's confidence in her body's capacity to give birth. It gives women the power to use her natural delivering instincts to make sure the baby is born peacefully, serenely, and comfortably.

Each delivery method has advantages and disadvantages. It is advised to choose a less painful delivery procedure while deciding on the type of delivery. Additionally, it is crucial to consider the mother's health. A doctor will advise you to use the technique that will assist you deliver your baby without incident.

In addition to living to bear this much of pain body needed complete nutrition and dietary practices which can happen only if the pregnant women have all the knowledge required to maintain her health good to face delivery and to deliver healthy baby also.

### **2.2.1 Nutritional requirements during Pregnancy**

We all require nutrients since they are essential structural and supporting elements. However, more than anybody else, pregnant women require the support of nourishment because

- The body is stimulated by nutrients.
- They aid in increasing the baby's birth weight.
- The birthing procedure can be made simple and risk-free with the right nutrients.
- For an unborn child's developing brain to function properly, nutrition is crucial.

Therefore, if you're curious about the crucial components to ensuring that you satisfy your nutritional needs while pregnant, keep reading.

What Essential Nutrients Are Necessary During Pregnancy?

The following nutrients are crucial for a fetus's proper development:

#### **FOLIC ACID:**

Folic acid is crucial because it lowers the risk of any prenatal or postnatal problems. Additionally, it is in charge of ensuring that the baby's brain and spinal cord develop normally. Pregnant women ought to consume 400 to 600 micrograms of folic acid on a daily basis prior to and shortly after becoming pregnant.

Each and every cell in the human body requires the nutrient folic acid for proper growth and development. It can help safeguard your child from neural tube defects, which are malformations of the spine and brain, if you take it prior to becoming pregnant and throughout the first trimester. The portion of a baby that develops into both the spinal cord and the brain is called the neural tube. NTDs occur in the first trimester of pregnancy, when you may not even be aware that you are expecting. This is why it's crucial to consume adequate folic acid before becoming pregnant.

In the US, NTDs impact roughly 3,000 pregnancies annually. Preventing up to 7 out of 10 (70 percent)

NTDs may be possible if all women consume 400 mgs (commonly known as mcg) of folic acid each day before becoming pregnant and during the first trimester. All women who are capable of becoming pregnant ought to receive folic acid supplementation every day because over half of all conceptions in the US are unplanned.

Several methods exist to obtain adequate folic acid:

- Taking a folic acid-containing vitamin
- Eating a variety of foods that contain folate
- Consuming enriched meals
- Combining the two: ingesting fortified meals and taking a folic acid-containing vitamin

Take a daily prenatal vitamin that contains 600 micro grams of folic acid every day while you are pregnant. Only prior to and during the initial few months of pregnancy does folic acid prevent NTDs. As your pregnancy progresses, you'll need 600 micro grams of the mineral daily to support your baby's growth and development.

### **High-risk females for NTDs**

Consume four thousand milligrams of folic acid supplements daily if you have a high chance of giving birth to a child with an NTD. From three months before to conception until the first 12 weeks of pregnancy, start consuming 4,000 mcg oral folic acid supplements daily. You run a significant risk of dying if:

- Previously gave birth to a child with an NTD.
- Either you or your spouse has an NTD.

### **Source of Food and Nutrient Content:**

The nutritional content of certain food items that are advantageous for pregnant women is shown in the table below.

| <b>Source Food</b> | <b>Serving Size</b> | <b>Amount of Folic Acid</b> |
|--------------------|---------------------|-----------------------------|
| Cereal             | 15 g                | 100 to 700 mcg              |
| Beans              | 89 g                | 90 mcg                      |
| Oranges            | 96 g                | 29 mcg                      |
| Spinach            | 95 g                | 131 mcg                     |
| Peanuts            | 28 g                | 27 mcg                      |
| Asparagus          | 60 g                | 89 mcg                      |

### **VITAMIN D**

Our skin absorbs vitamin D from sunlight, and some foods also contain it. When we are outside in the summer sun, we produce the bulk of the vitamin D we need for the year. This often occurs from the end of March through early April until September. In the shadow or under overcast conditions, our bodies produce less vitamin D, and vitamin D cannot be absorbed through windows. Everybody has a different threshold for how much time they must spend in sunlight to produce enough vitamin

D. The skin's type, the moment of day, and the season all play a role. Every day, pregnant women should supplement with 10 micrograms (or 400 IU) of vitamin D. Your infant will receive adequate vitamin D from this for the first couple of years of life.

Throughout the autumn and winter, this advice is strongly suggested, and it is suggested during the spring and summer. A daily vitamin D intake of in excess of one hundred micrograms (4,000 IU) may be dangerous. Mothers who are nursing ought to administer a vitamin D supplement.

Together with calcium, vitamin D aids in the healthy development of the baby's teeth and bones. Additionally, it contributes to the mother's overall health. Pregnant women as well as other people should consume a minimum of 600 international units of vitamin D from food each day. Between September and March, you should think about taking a supplement that contains 10 micrograms of sunshine vitamin every day.

The body needs calcium and phosphate to maintain strong bones, teeth, and muscles, and vitamin D controls how much of these minerals are present. Whenever our skin is illuminated by summertime sunshine (from latter March/early Spring to the final month of September), our bodies begin to produce vitamin D.

Some morning cereals, fat spreads, and non-dairy milk substitutes contain vitamin D. These goods may have tiny or varying levels of additives. It is challenging to obtain enough vitamin D from diet alone because it is only present in a few number of meals, whether naturally occurring or supplemented.

A daily vitamin D intake of in excess of one hundred micrograms (4,000 IU) may be dangerous. If you are nursing or are pregnant and you are eligible for the Good Start programme, you can receive nutritional supplements including vitamin D from free of charge.

#### **Source of Food and Nutrient Content:**

The nutritional content of certain types of food that are advantageous for pregnant women is shown in the table below.

| <b>Source Food</b> | <b>Serving Size</b> | <b>Amount of Vitamin D</b> |
|--------------------|---------------------|----------------------------|
| Milk               | 237 mL              | 115 IU                     |
| Juice              | 237mL               | 100 IU                     |
| Eggs               | 50 g                | 44 IU                      |
| Fish               | 85 g                | 570 IU                     |

#### **PROTEIN:**

Big biomolecules or macromolecules known as proteins are primarily consumed to increase body muscle mass. A collection of amino acids make up proteins, which are employed by the body to carry out a number of tasks include DNA replication, catalyzing metabolic processes, responding to stimuli, and helping to transport molecules. These advantages of protein contribute to preserving excellent health. Maintaining a healthy way of life is crucial throughout pregnancy. Healthy eating provides the mother and the kid with the nutrition they need for growth. One of the nutrients thought to be crucial for growth is protein. We'll talk about the value of eating protein in this blog post, especially when you're pregnant.

During pregnancy, protein is crucial. It supports the other critical regions of the baby's development

and aids in normal growth. The importance of consuming protein while pregnant is:

- It aids in the development and restoration of both the mother's and the child's new and damaged tissues.
- Both the mother's body and the child benefit from its contribution to antibody production.
- It aids in the creation and secretion of hormones, which are crucial for both the mother's health and the fetus throughout pregnancy.
- Protein is crucial for the growth of the mother & the child's development of muscular mass.
- Consuming protein helps to transport oxygen throughout the mother's body and to the developing fetus.
- Inadequate protein intake during pregnancy can result in significant fluid retention, muscle tiredness, weight loss, and frequent infections.

For a baby to grow properly throughout pregnancy, the ideal quantity of protein is essential. It is a nutrient for growing muscles and assists a baby's tissues and muscles to develop more effectively. Protein is also responsible for the development of the uterine and breast tissue in pregnant women. Additionally, it promotes better blood circulation. Recommended everyday Intake: Pregnant women require between 70 to 100 gms of protein every day.

During pregnancy, protein serves as a framework for newborn's cell and aids in the development of their muscles, skin, hair, and nails. A variety of factors such as your weight, amount of physical activity, and trimester, you need anywhere between 60 and 100 grams of protein per day while pregnant. Fortunately, there are lots of options for protein-rich foods, such as meat, chicken, seafood, egg yolks, milk, cheese, vegetarian tofu, and beans. Before consuming protein drinks and powders during pregnancy, consult with your healthcare professional.

Cells and those of the unborn child are made up of amino acids, which are the components that comprise up protein. The infant needs protein to grow healthy skin, hair, fingertips, and muscles. Additionally, it affects the fluid balance in your body that might help you have a healthy blood pressure and avoid pregnancy edema. While getting enough protein is vital throughout your pregnancy, the second & third trimesters are particularly important. Your baby is growing at its fastest during this time, and your body is expanding significantly to accommodate your growing kid.

A variety of factors including your weight, amount of physical activity, and trimester, your daily protein needs during pregnancy might range from 60 to 100 grams. Visit [MyPlate.gov](https://www.MyPlate.gov) to establish a customized meal plan to determine how much proteins your body requires each day.

You generally won't have any issue meeting the demands of your body for protein throughout pregnancy since the majority of women in the US frequently consume more protein than they need. If you don't consume meat, you can still get enough protein from other foods, such as dairy, eggs, beans, or soy products. You may have weight loss, muscle tiredness, recurrent infections, and significant fluid retention if your diet is lacking in protein.

Great places to get protein include lean meat, chicken, fish, shellfish, eggs, dairy products, cheese, tofu, yoghurt, and beans. Eating an assortment of foods during the day can assist guarantee that you get every one of the amino acids that you require. Complete proteins are proteins that contain all nine amino acids. Plant sources typically do not. Pregnant vegetarians and vegans can obtain sufficient amounts of protein and other essential nutrients without consuming animal products, but it takes more preparation.

The normal development of a baby's tissues and organs, especially the brain, depends on protein.

Additionally, it aids in the development of uterine and breast tissue while pregnant. Even your blood supply is affected, making it possible to give your kid extra blood.

Every trimester of pregnancy will increase your requirement for protein. According to research, pregnant women should consume significantly more protein than what is now advised. It's time to serve more fish teriyaki, jerk chicken, hog curries and shrimp fajitas.

A number of factors, such as your weight and the trimester you're in, you'll need to eat between 70 and 100 g of protein every day. Find out specifically how much you require by speaking with your doctor.

### **Source of Food and Nutrient Content:**

The nutritional content of certain food items that are considered advantageous for pregnant women is shown in the table below.

| <b>Source Food</b> | <b>Serving Size</b> | <b>Amount of Protein</b> |
|--------------------|---------------------|--------------------------|
| Peanut Butter      | 32 g                | 7 g                      |
| Cottage cheese     | 226 g               | 28 g                     |
| Poultry            | 86 g                | 26 g                     |
| Egg                | 50 g                | 6 g                      |
| Fish               | 85 g                | 17 g                     |
| Milk               | 237 mL              | 8 g                      |
| Lentils            | 99 g                | 9 g                      |

### **CALCIUM:**

Among the most vital minerals for pregnancy for body formation is calcium. It benefits both a mother's and her developing child's bone health. As a result, it also contributes to a baby's correct spinal cord development and lowers the risk of bone malformation. Recommended daily Intake: For improved baby growth, pregnant women need to consume 1000 mg of calcium daily.

Developing baby requires calcium during pregnancy to grow teeth and bones that are durable as well as a healthy heart, nervous system, and muscles. Additionally lowering the likelihood of hypertensive and preeclampsia is getting enough calcium. The best sources of calcium are milk and other dairy products, canned fish, calcium-fortified cereal, juice, soybean and rice beverages, and bread. Consult healthcare practitioner about considering a calcium supplement if you believe you are not receiving enough calcium through your diet and prenatal vitamin.

The growing unborn child requires calcium during pregnancy to form teeth and bones that are durable. Additionally, calcium aids in the development of healthy hearts, nerve endings, and muscles in addition to a regular heartbeat and the capacity for blood clotting. During the final three months of the being pregnant, when your baby begins to develop swiftly and needs the most calcium, it's crucial to get an adequate amount of calcium in diet.

You can also lower your risk of hypertensive and preeclampsia by consuming calcium. Additionally, if you don't consume enough calcium throughout pregnancy, your kid will suck it from the bones in their bodies, which could subsequently harm your own health.

The easiest method to receive the necessary daily amount of calcium is through a diet that is nutritious, but if you feel you aren't receiving it, talk to physician about maybe adding an additional calcium supplement.

Prenatal vitamins have varied levels of calcium, with some offering 100 to 200 mg, so keep this in mind before taking supplements. Less under five hundred milligrams of ca at a time is the optimal amount for your body to absorb. Therefore, you might need to utilize your calcium supplement in little dosages numerous times throughout the day.

Make sure to acquire adequate vitamin D within diet while you are pregnant since you need it to absorb calcium. The most popular types of supplemental calcium are carbonate of calcium and calcium citrate. The most calcium-rich form of calcium is calcium carbonate, but because it needs more stomach acid to be dissolved, it is best taken with food.

The body can most readily absorb calcium citrate. It is possible to take this type between meals because it requires no stomach acid for absorption. (Those using heartburn medications that lower stomach acid should consider it.) Look for a supplement whose label reads "USP" (for U.S. Pharmacopoeia). This shows that the supplement is devoid of lead and other dangerous metals, has a suitable calcium content, and will dissolve easily. Avoid calcium supplements that contain bone meal, dolomite, shellfish, oysters, or coral since they may contain trace amounts of lead that could endanger your developing child.

Don't go overboard, too. Make sure that the sum of your daily intake from nourishment, vitamins, and water is no more than 2500 mcg (or 3000 mg assuming you are under the age of 18). A diet high in calcium may make it difficult for your body to absorb zinc and iron from meals, raise the possibility of kidney damage, and induce constipation.

#### **Source of Food and Nutrient Content:**

The nutritional content of certain foods that are advantageous for pregnant women is shown in the table below.

| <b>Source Food</b> | <b>Serving Size</b> | <b>Amount of Calcium</b> |
|--------------------|---------------------|--------------------------|
| Yoghurt            | 170 g               | 258 mg                   |
| Cheese             | 43 g                | 333 mg                   |
| Milk               | 237 mL              | 299 mg                   |
| Juice              | 237 mL              | 349 mg                   |
| Salmon             | 85 g                | 181 mg                   |
| Spinach            | 95 g                | 123 mg                   |
| Cereal             | 20 to 60 g          | 100 to 1000 mg           |

#### **IRON:**

Haemoglobin, the most crucial component of red blood cells, requires iron to function. Additionally, it increases the flow of oxygen to various bodily regions. Additionally, consuming the appropriate quantity of iron can help treat the fairly common condition of anaemia. To prevent anaemia and iron deficiency, pregnant women should consume 27 mg of iron per day.

Despite the brief respite from iron losses seen during menstruation, the overall requirement for iron during pregnancy is much higher than that within the nonpregnant state. Because of the growth in red blood cell bulk and the increased iron transport to both the developing foetus and the placental tissues, iron requirements noticeably rise during the latter stages of pregnancy. At parturition, iron is also lost from the maternal blood and lochia. The amount of iron in the diet that can be consumed during pregnancy as well as the size of iron reserves at the beginning of pregnancy determine how well these higher requirements can be satisfied. The common development of iron deficiency anemia during pregnancy suggests that the physiologic adjustments are frequently insufficient to satisfy the increasing demands. Because of this, taking iron supplements when pregnant is a widespread practice. There is a clear unequal distribution across time when overall requirements for iron during pregnancy transform into higher daily needs. Iron needs increase to anywhere from four to six mg in the later stages of pregnancy, although being lower in the first trimester. Iron requirements during the last 6-8 weeks of pregnancy may reach as high as 10 mg/d due to the fact that significant changes in red blood cell mass do not begin to occur until the latter part of the second trimester. Regardless of the precise figure, it is clear that even the healthiest diet cannot provide enough iron to meet daily needs in the latter stages of pregnancy.

Overall utilization of iron is typically 3–4 mg/d and, no more than 5 mg/d in diets rich in bioavailable iron, such as those that include considerable amounts of meat, poultry, seafood, and foods high in ascorbic acid. When the diet only contains tiny levels of accessible iron, as is frequently the situation in many underdeveloped nations where cereal is the main food and the consumption of meat and vitamins C and E is restricted, less iron is absorbed.

#### **Source of Food and Nutrient Content:**

The nutritional content of certain types of food that are advantageous for pregnant women is shown in the table below.

| <b>Source Food</b> | <b>Serving Size</b> | <b>Amount of Calcium</b> |
|--------------------|---------------------|--------------------------|
| Meat               | 85 g                | 3 mg                     |
| Cereal             | 40 g                | 20 mg                    |
| Beans              | 88.5 g              | 2 mg                     |
| Poultry            | 85 g                | 1 g                      |
| Spinach            | 90 g                | 3 mg                     |

Depending on their condition, pregnant women may also require several other nutrients in addition to these essential ones to meet their nutritional needs. These include vitamins D, C, B6, B12, and others. The entire list includes both body-building and body-protecting nutrients that support healthy mother and child development.

### **2.2.2 Nutritional care after delivery**

New mother & her baby were sustained for nine months by the food you ate. However, the diet remains just as crucial after giving birth. It supports body's healing process and provides with the mental clarity you need to look after the child. Most new mothers require approximately 1,800 or 2,200 calories per day in the months following childbirth. Nursing? You could need an additional 500. This amount may be higher if you are underweight, exercise over 45 minutes every day, or are nursing more than one child. Consult your doctor to decide the proper dosage for you as well as the

length of time you should continue taking supplements.

Despite not "eating for two," your body still needs to replenish a number of vital nutrients. Fill half of the plate with vegetables and fruits at every meal. Muesli, whole-grain bread and brown rice should make up the other half of the meal. Limit your intake of packaged, processed items like sodas and foods that are heavy in salt, cholesterol, saturated fat, and added sugars.

The majority of first-time mothers shed 4.5 kilogrammes of baby weight every month. You might be tempted to start a diet to hasten the process, but you shouldn't do that. Your energy levels and attitude will drastically decline if you consume less than 1,800 calories. If you don't eat enough while nursing, you risk endangering your infant as well.

The best course of action is to keep to a nutritious, balanced diet and begin exercising as soon as your doctor gives the all-clear. After around 6 weeks, you can normally start a walking programme. Resuming your pre-baby training regimen should be done gradually and with caution. Whatever you eat can get into your baby through the milk you produce if you're nursing. Take care of:

- **Alcohol:** When it comes to what quantity (if any) is acceptable for a baby as well as how long women should wait before breastfeeding after consuming alcohol, experts have differing views. Consult your doctor to determine what is best for you.
- **Caffeine** might affect your baby's sleep as well as temperament (they might become cranky) if you consume more than three cups (24 tablespoons) of brewed coffee or soda each day.

Avoid these species because they are high in the metal mercury, a toxin that is dangerous for your unborn child: swordfish, sharks king mackerel, and tilefish. Mercury can also be present in tuna. Eat a maximum of than 6 ounces every week and only the "light" variety.

### **Additional Nutritional Aspects**

Have wholesome foods on hand. You'll probably choose fresh fruit and vegetables over chips or cookies if you have them washed and prepared in the fridge. Remain hydrated. Regardless of whether you are nursing or not, aim for 6 to 10 glass of water per day. Fruit juice and milk are also options.

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## **2.3 Dietary Counseling**

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A woman and her family can improve their nutrition by making decisions and taking action with the aid of maternal nutrition counselling. This comprises choices and behaviors on the kinds, variety, and quantities of food a woman should eat to satisfy her dietary needs, the quantity of exercise she requires, and the usage of dietary supplements.

Even though such assistance is a suggested part of healthcare, many women fail to receive high-quality nutrition guidance. In order to recover her regular energy and health after giving birth, women should eat more frequently than usual. This will help to cover the cost of electricity of breastfeeding. If she is not moving about much or working as usual, she should consume around 10% of what she did before she was pregnant; if she is vigorously exercising, she should eat about 20% more. She is urged to eat an additional meal or two each day, at the absolute least. Included in nutritional counselling should be:

- Encouraging the mother that she consume a range of high protein, energy-dense meals, including meat, milk, seafood, oils, nuts, seeds, grains, beans, and cheese (as much as the entire household can afford), to keep her strong and healthy. Your dietary recommendations have to be based on what they typically consume and what is available to them at home. Telling them that she wants to eat greater than normal is the most crucial step.

- Investigating whether there are any significant cultural taboos associated with eating genuinely nutritious meals. For instance, eating cold, spicy, or high-protein foods right after giving birth is frowned upon in several cultures. Respectfully counsel the woman to avoid these taboos and inform her that at the moment there is no nutrient-rich food available.
- Speak with family members, especially the spouse and/or mother-in-law, and urge them to make sure the woman consumes enough of a variety of meals and stays away from strenuous physical activity.

Healthy eating is essential for new mothers. In order to maintain their health and produce good breast milk, nursing women require an additional 500 calories per day in addition to enough of protein, calcium, and water.

Eat a variety of fresh produce and fruit, proteins that are lean, high-fiber foods, dairy products that are low in fat, and other healthy foods as part of an overall balanced diet. The U.S. United States Department of Agriculture's (USDA) My Plate recommendations are a great resource for additional advice because they include excellent details about your nutritional requirements.

You should abide by the USDA's advice, which includes:

- Take use of the fats found in fish, nuts, and vegetable oils.
- Limit items that contain solid fats, such as butter, stick margarine, shortening, and lard.
- You should always read the nutrition information on the food you buy and steer clear of products that are high in sodium, trans fats, and fats.
- Pick products with few added sugars for your meals and drinks.
- After giving birth, eating healthily can help you reduce up to 20 pounds. When combined with a sensible diet plan, moderate activity, and healthy eating, you may be able drop even more weight.

## **Sleep and rest**

One among the biggest difficulties for new parents is sleep deprivation. Every between two and three hours throughout the clock, your baby will require assistance to eat, be changed, soothed, and held. Your infant can establish a sleeping routine that differs significantly from yours and might even cry for a portion of the day. It is quite simple for the weariness and stress that can come from a prolonged lack with sleep in the new-born's first few weeks of life to overwhelm the positive aspects of parenthood.

- Prepare straightforward meals at convenient mealtimes.
- When your infant is sleeping, you should too.
- Rest should come first; tasks can wait.
- Maintain a loose, flexible schedule at home.
- Accept offers of assistance with cooking, cleaning, and shopping.
- Request assistance from family and friends to look after older kids.
- Delay important household projects.
- Avoid items like soda, coffee, tea, and chocolate that contain caffeine.
- When you need assistance, ask for it.

Whenever the baby is sleeping and you can't seem to go asleep, it could be helpful for you to curl up quietly, read, or watch a favourite show on television. Exercises that alternate between tensing and relaxing the muscles in your arms, legs, and feet may also be beneficial. Despite being a strongly advised aspect of healthcare, many women are denied high-quality nutrition advising services. The obstacles there are a number of common problems in low- and middle-income nations, although they vary depending on the environment for maternal nutrition advice.

First, a lack of political will or financial support frequently prevents the proper integration of maternal nutrition guidance into basic medical care.

Second, women's access to health care is not as good as it could be, especially in areas with inadequate access to basic healthcare and poor or non-existent community-based delivery systems.

Third, there are gaps in the numbers, distribution, training, and supervision of health professionals and community health workers, which makes it difficult for them to deliver excellent counselling on maternal nutrition. They also lack the expertise, skills, motivation, and time to do so.

Fourth, counselling methods, resources, and messages are not tailored to the local environment, which includes the sociocultural norms, economic background, and social practises that affect maternal nutrition practises. Fifth, programmes frequently don't have defined therapy goals and aren't followed up on to gauge progress and keep management, medical professionals, and local healthcare providers accountable.

To pregnant women to be healthy and prevent excess body weight during the pregnancy in all situations, counselling regarding healthy eating and staying active is advised. Pregnant women should consume a variety of locally accessible nutritious meals, such as green and orange fruits and vegetables, meat, seafood, beans, nuts, pasteurised dairy products, fruit, and fortified foods, to ensure they are getting enough energy, protein, vitamins, and minerals.

Women should be the focus of counselling, and it should be offered without bias. In undernourished populations, increasing daily protein and energy intake is advised to lower the risk of low birthweight babies, while balanced nutritional and protein dietary supplements are advised to lower the risk of stillbirths and babies who are small for their gestational age. Women who are trying to get pregnant, women who are pregnant, and postpartum women (those who have just given birth to those who are at least six months postpartum) are the main target populations for maternal nutrition counselling. All women should have the opportunity to use counselling services, but it's critical that nations recognise the nutritionally vulnerable women who might need more intensive assistance, as well as the situations where the woman's family or other members of the community should also be the focus of counselling.

Individual therapy, which is widely regarded as the most successful type of counselling, enables a health professional or public health worker to concentrate on the particular needs and issues of a woman. It is typically given face-to-face to a patient at a medical facility, in the neighbourhood, or at home. Individual counselling can take a lot of time, and in some settings, it might be difficult to give the necessary privacy and space.

Recent years have seen a rise in the usage of distant methods, such as internet telephony, mobile phones, and telephone helplines. These methods can be useful in situations when access to the availability of face-to-face counselling may be restricted or non-existent. However, not all women have access to them, and additional research is required to understand their efficacy in various situations.

A health professional, a community health worker, or a layperson (such as a mother support group participant) facilitates group therapy at the institutional or community level. When group

participants share similar issues, problems, and sociocultural backgrounds, counselling in groups is most effective. Because it enables interaction, efficiency might be increased.

While working with many clients. Building socially supportive ties and exchanging experiences with one another might be advantageous for the participants. Group counselling, however, may not be able to meet the individual needs of some people (including women who are nutritionally at risk) or create a safe space for all adolescent girls and women to talk about their issues. This is particularly true in situations that occur when there are perceived distinctions among group members, such as those based on age, ethnicity, caste, or sociocultural background.

## 2.4 Let Us Sum Up

A woman must regain all of the lost energy as well as nutrients throughout the key stages of pregnancy and lactation. To keep up with the constant demands of her infant, the new mother must restore all of her lost power and stamina. To be able to achieve this, the new mother must eat a nutritious diet because it aids in the process of healing after giving birth and carrying the kid for months. The optimum time to provide the body with hormone-regulating and health-promoting nourishment is during pregnancy, and Indian foods are available to purchase after delivery. It is essential to choose wholesome meals so that you can receive the advantages of whole nutrients while also feeling satisfied because your body needs quick refueling in terms of nutrition.

## 2.5 Check Your Progress Exercises

### 2.5.1 What Essential Nutrients Are Necessary During Pregnancy?

This image shows a full page of blank white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for writing or drawing. There are no margins, text, or other markings on the paper.

### 2.5.2 Explain the importance of folic acid requirement during pregnancy?

### 2.5.3 Elaborate the utilization of Calcium and protein during pregnancy?

MFN-106/26

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## **UNIT-3 : DIET, NUTRIENT & DRUG INTERACTION**

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### **STRUCTURE**

- 3.1 Introduction
- 3.2 Effect of Drug on Ingestion of Nutrients
- 3.3 Effect of Drug on Absorption of Nutrients
- 3.4 Effect of Drug on Metabolism of Nutrients
- 3.5 Effect of Food and Nutrient on Drug dose and Efficacy
- 3.6 Effect of Nutritional status on Drug dose and Efficacy
- 3.7 Let Us Sum Up
- 3.8 Check Your Progress Exercises

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### **3.1 Introduction**

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Foods can speed up, slow down, or increase the absorption of drugs. The breakdown of many antibiotics is hampered by food. They have the power to change how medications are metabolized. For instance, high-protein diets can speed up the metabolism of some pharmaceuticals by activating cytochrome P-450. Consuming grapefruit can suppress the enzyme cytochrome P-450 3A4, which slows the metabolism of several medications (such as statins, amiodarone, carbamazepine, and cyclosporine). Diets that change the balance of bacteria may have a significant impact on how some medications are generally metabolized. Some meals influence how the body reacts to medications. For instance, certain individuals who consume cheese while on monoamine oxidase inhibitors may experience hypertensive crisis due to tyramine, a powerful vasoconstrictor found in cheese.

Drugs that interact with nutrients fall into two categories:

- i) Negatively impact nutritional status by affecting food intake and/or nutrient absorption, metabolism, and excretion, and
- ii) On the other hand, nutritional status can have a negative impact on drug metabolism by reducing their absorption and, in turn, their effectiveness.

Drug metabolism and absorption might be impacted by nutritional deficits. Severe protein and energy deficiency decreases the amounts of tissue enzymes and may affect how well medications work by lowering absorption or binding to proteins and resulting in liver failure. Changes in the digestive system might hinder absorption and alter a drug's effect. Drug metabolism may be hampered by magnesium, calcium, or zinc deficiency. Drug-metabolizing enzyme activity is decreased by vitamin C insufficiency, particularly in elderly individuals. Many drugs have an impact on desire for food, consumption of food, and tissue metabolism. Metoclopramide is one medication that increases gastrointestinal motility and reduces food absorption. The digestive system's motility is reduced by other medicines, such as opioids and anticholinergics. Some medications are tolerated better when taken with food.

The working definition of drug-nutrient interactions is broader than those frequently utilized elsewhere. It is defined as a link between a medicine and a nutrient, multiple nutrients, food in general or nutritional state that results in an interaction that is chemical, physical, physiologic, or pathophysiologic. If an interaction modifies pharmacotherapeutic response or jeopardizes nutritional status, it is deemed clinically significant. Changes in the absorption and impact of the medicine or nutrient are related to the clinical effects of an interaction. Disposition describes how a medicine or

food is absorbed, distributed, and eliminated; it may involve hemodynamic transporters and metabolizing enzymes. The physiologic activity of a medicine or food at the cellular or sub cellular level is referred to as an effect. Health outcomes can be affected by drug-nutrient interactions, especially in vulnerable groups.

In this unit student will learn about nutrient drug interaction as well as the impact & effect of drugs on metabolic processes.

**OBJECTIVE:**

1. Students will learn about nutrient drug interaction.
2. They gain knowledge about food & drug interaction, absorption & metabolism also.

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### **3.2 Effect of Drug on Ingestion of Nutrients**

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A medication's impact on food or a nutrient therein is referred to as a drug-nutrient interaction. Numerous interactions exist between medications and diet and nutrition. The way a nutrient gets absorbed, metabolized, or eliminated can be altered by medications. The impact of food or any nutrients in food on a drug's effectiveness is known as a food-drug interaction. The absorption or metabolism of drugs can be changed by dietary nutrition. Your diet may affect how quickly or slowly your medications function, or even whether they work at all.

The precise impacts of the linkages on the body are difficult to ascertain due to the intricate connections among food, nutrients, and medications. A chemical used in the prevention, treatment, or diagnosis of an illness, or a component of a pharmaceutical, is referred to as a drug. Food-drug, drug-drug, including alcohol-food-drug combinations can have a variety of dramatic effects and issues, which differ from individual to person. Drug-nutrient interactions refer to adjustments made to a drug as a result of an adjustment made to a nutrient. The adverse effects of a medication on nutritional status are referred to as food-drug interactions. Each of these interconnections could result in a variety of problems.

Such interactions give rise to worries that drugs could cause nutritional shortages or that eating habits could alter how a drug works. This does not imply that you must take a vitamin or mineral supplement if you are taking medication. It is unlikely that taking a drug for a little period of time, such a ten-day course of therapy, will have an impact on your nutritional state. However, long-term usage of some drugs may have an impact on your nutritional health. The likelihood that a medicine will negatively impact a patient's nutritional health is higher among children, older people, pregnant women, malnourished patients, and patients with chronic diseases. Adding more vitamin and mineral-rich foods to one's diet is preferable to taking vitamins or mineral supplements.

Over-the-counter as well as prescription drugs can have an impact on how the body processes nutrients. Drug-nutrient interactions may cause vitamin or mineral deficits in those who take drugs for extended periods of time.

There are numerous interactions between medication and diet. Drugs and nutrients frequently employ the same organs for metabolism and excretion as well as similar locations for absorption.

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### **3.3 Effect of Drug on Absorption of Nutrients**

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Investigations into absorption interactions help to spot instances in which external influences affect a drug's solubility, dissolution, or absorption. It is important to evaluate studies on the impact of altered intestinal active transport, complex binding, and raised gastrointestinal pH. Drugs that regulate intestinal and stomach motility may be significant in some circumstances. The mode of management, bioavailability, and physicochemical characteristics of the investigational medicine all

affect which studies are required for a given pharmaceutical product.

The information below makes reference to intravenous formulations and emphasizes that interactions at the level of absorption should be addressed primarily for investigational medications that are supplied orally. However, interactions should also be taken into account for nasal and inhalation products that have the potential to be absorbed orally.

### **A. Solubility-affecting interactions**

Antiprotein pump inhibitors, H<sub>2</sub>-receptor antagonists, or antacids should all be examined in vivo for their ability to elevate gastric pH if the solubility or dissolution of the formulation is notably pH dependent in the physiological pH range. It might be required if the drug's physicochemical qualities indicate it.

### **B. Intestinal active transport-affecting interactions**

To predict interactions where the drug's absorption is altered as a result of the inhibition or stimulation of these proteins, the significance of protein carriers (transporters) in the absorption of drugs is assessed. Drug exposure to the whole body and/or C<sub>max</sub> can be reduced by intestinal uptake transporter inhibition or absence. Due to enhanced absorption and/or decreased availability of the drug to gastrointestinal drug metabolizing enzymes (such as CYP3A), inhibition of an intestine efflux transporter may increase systemic drug exposure and/or C<sub>max</sub>. It is advised that in vitro testing using Caco-2 cells be done to determine the role of transports in drug absorption. The permeability of the body is used to assess the significance of active transport towards drug absorption. The permeability of the drug being studied should be subject to consideration when determining how important active transport is for drug absorption. Attempts should be made to find the transporter responsible in vitro if the in vitro movement and penetration results suggest that active gastrointestinal transport may alter the absorption and reabsorption of the new medicine.

Through a variety of processes, drugs can raise nutrient needs, and if those needs are not satisfied through dietary changes or the administration of nutrient dietary supplements, deficiency diseases will ensue. The subtle onset of hypovitaminoses is one of the more common nutritional effects of drugs. Other serious nutritional effects of drug use include growth retardation and, in the case of vitamin inhibitors, poisoning due to interference alongside metabolic processes that depend on the activity of supplements or coenzymes. Pharmacologic substances and nutrients may interact in ways that affect how they are absorbed, transported, processed, and excreted. Multiple therapies can deplete nutritional reserves by a synergistic impact, while single drugs can decrease nutrient stores by more than one method. Drug-induced malnutrition risks rise with dosage and usage time, and with poor diets and the presence of an illness, which raises the need for the same micronutrients that the medicine affects.

Absorption of nutrients can be impacted by drugs. Insoluble phosphate salts are created when antacids with aluminium or the mineral magnesium hydroxide bond to dietary phosphate. These salts are incapable of being absorbed. Abuse of antacids has been linked to osteomalacia due to phosphate deficiency.

### **Tetracyclines**

Tetracyclines easily chelate with the divalent and trivalent cations of metals (such as calcium, magnesium, and iron), whose concentrations are higher in enteral feed or milk-based diets than in regular diets. Reduced reception from the GI tract results from size and solubility changes in the chelated drug molecule. If tetracycline is given along with a nourishing diet, its absorption can be lowered by 80%. However, unlike previous tetracyclines, milk and food consumption concurrently do not impact the absorption of doxycycline.

## **Macrolides**

If ciprofloxacin is administered along with enteral nutrition, its absorption is reduced by 50%. This is believed to be the result of drug molecules' affinity for divalent ions. Levofloxacin and ofloxacin both cause a comparable reaction, but one that is less severe. With moxifloxacin, there is no response. Additionally, ciprofloxacin chelates with the ions in mineral or tap water. The importance of this relationship, however, has not yet been the subject of published research.

## **Involving proteins**

Warfarin and phenytoin reports of decreased absorption point out the possibility that a medicine could bind to protein from foods in the digestive tract and impair absorption. There are frequently no publications comparing the interactions between these medications and entire food protein to those with amino acid sequences present in enteral feeds.

## **Inulin and fibre**

Pectin, which is found in fruit such as pears and apples, inhibits the absorption of paracetamol, though the relevance of the relationship is uncertain. Digoxin's absorption is lowered if it is consumed concurrently with fiber-rich meals. If a patient significantly reduces their intake of fibre (e.g., switching from a high-fiber normal diet to a low-fiber enteral feed), digoxin concentrations in the blood should be closely monitored. However, the consequence of this is minimal for patients who consume a healthy, balanced diet due to the drug's narrow therapeutic index.

## **Effects of indirect absorption**

The majority of medications are taken by passive diffusion across the GI mucosa from the lumen of the stomach into the splanchnic circulation. The duration of the drug's interaction with the mucosa and its lipophilicity both affect the rate of diffusion. Gastric emptying that is delayed.

More so than meals high in protein or carbohydrates, meals that are hot or greasy delay stomach emptying. It has two outcomes:

- The length of time a medicine stays in the stomach can affect how well it dissolves and disintegrates (and presumably how acid-sensitive drugs fare).
- It prolongs the time it takes for medications ingested from the small intestine to reach their peak blood concentrations.

In general, the combined impact increases drug absorption overall, and the postponement and decrease in maximum plasma concentrations may be advantageous (for instance, taking nifedipine with food postpones and lessens the intensity of the medication's flushing adverse effect).

## **Increased bioavailability in the liver**

When food and enteral feed is present in the small intestine, splanchnic blood flow is increased. Due to the lower flow of blood through the system known as portals (to the liver), this may improve drug absorption and may also boost bioavailability. This is the proposed reason for why taking propranolol and metoprolol with food increases their concentrations compared to taking them when fasting.

## **Additional GI effects**

Highly lipid-soluble medications like griseofulvin may be more easily absorbed when bile salts, which are generated in the aftermath of fat consumption, are present.

Drugs may impair the GI tract's ability to absorb nutrients. For instance, metformin used long-term is linked to vitamin B12 insufficiency and colchicine is linked to a malabsorptive diarrhea. Some

medications, such as methyldopa and levodopa, traverse the mucosa of the gastrointestinal tract using active transport mechanisms that are typically employed to transfer nutrients. A diet rich in protein reduces the digestion of such medications.

### **Feed consistency changes**

A physical relationship between the medicine and a feed component or the feed formulations results in a change in the physical consistency of the feed, which is what causes consistency changes in feed. This may clog an alimentary tube or, in severe circumstances, physically obstruct the GI tract.

Sucralfate is the medication for which this type of interaction with enteral nutrition has been documented most frequently. This effect will be minimized by adequate flushing in between feedings and medicine delivery. A nutritional feed should never have medication administered straight to it.

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## **3.4 Effect of Drug on Metabolism of Nutrients**

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Studies on the elimination of the investigational medication as well as analyses of the enzymes catalyzing the primary systemic and pre-systemic clearance routes are frequently included in investigations into how the metabolizing process of the investigational medicine is impacted by other pharmaceuticals. It's also important to take into account the key enzymes that catalyze the primary processes of pharmacologically relevant metabolite synthesis and further elimination. Prior to beginning phase I, research on in vitro metabolism should typically be carried out to determine the primary metabolites produced there. These studies enable for early screening of the key metabolites discovered in vitro for target pharmacological activity and offer information required for extrapolating preclinical safety data to humans.

Additionally, in vitro research should be done to find potential enzymes involved in the parent drug's primary metabolic processes.

Drug metabolism may be impaired by poor nutrition. People with compromised hepatic, renal, or gastro-intestinal function are at higher risk for drug-nutrient interactions.

- Have dietary deficiencies as a result of chronic illness.
- Have recently lost weight or been dehydrated.
- Are receiving lengthy and multiple medication therapies.
- Have altered the amount of lean tissue, total body fluids, and plasma levels of proteins due to advancing age.

Drug therapy can have a negative impact on nutritional status, and the medications that are most likely to do so are those that:

- Have a limited therapeutic window.
- Must be taken for extended periods of time.
- Impact when and how much food is consumed.
- Call for dietary limitations or regulations.
- Possess side effects that affect digestion and appetite.
- Directly compete with nutrition

The majority of prescription and over-the-counter medications prescribed for chronic conditions like hypertension, diabetes, and cardiovascular disease are known to be consumed by the elderly.

Furthermore, they greater the chance of receiving medications that could affect nutritional status, such as cytotoxics and anti-Parkinson's medications. The cause(s) of the recognized increased susceptibility to drug-induced adverse events include declining hearing, vision, and memory; decreased salivation, which can enable bulky medications to attach to the oesophageal mucosa; and impaired movement, which frequently results in poor compliance or inappropriate dosing.

Following oral administration, the medication travels from the gastrointestinal tract lumen to the intestinal erythrocytes. The medicine is typically attached to plasma proteins when it is transported in the blood. Deactivation is accomplished through a two-step metabolic process that involves oxidation by microsomal enzymes in the liver, lungs, and small intestine that involve NADPH and cytochrome P450 and conjugated with glucuronic acid, sulphate, or glycine. The conjugate is then eliminated by the bile or urine.

Food consumption can decrease, delay, or boost a drug's absorption. As a result of:

- Delayed gastric emptying, the accumulation of food in the gastrointestinal tract and proximal intestines may decrease medication absorption.
- A change in stomach pH.
- Nutrient competition for binding sites.
- Drug chelation using dietary cations, such as tetracycline and calcium ions in milk.
- Dietary fats preventing hydrophilic medicines from being absorbed.

### **Connections between metabolisms**

Various foods can impact how drugs are metabolized. Though interactions with the juice of pomegranates have only lately been discovered, the juice of grapefruit is still the most well-known.

#### **Orange juice**

A class of drug-metabolizing enzymes known as Cytochrome P450 is primarily present in the liver and small intestine. Furanocoumarins and other compounds included in grapefruit juice block intestinal CYP3A, slowing down the metabolism of medicines taken orally. Additionally, p-glycoprotein and other intestinal drug transporters may be blocked.

Numerous medicines are impacted by this interaction, according to research. The limited oral bioavailability of many medications suggests considerable presystemic breakdown in the liver or gut. Examples of medications that are impacted by this reaction are:

- Antibiotics (such as saquinavir, albendazole, and erythromycin)
- Medications for the heart (such as amiodarone, felodipine, and verapamil)
- inhibitors of phosphodiesterase type-5
- Immunosuppressive drugs, such as cyclosporin

#### **Pomegranate nectar**

Research is now being done to determine how pomegranate juice affects medication metabolism. It might have an impact on the enzyme CYP2C9, which fluconazole also inhibits. Pomegranate juice might have an impact on medications whose metabolism is influenced by fluconazole. This's clinical significance is currently not known.

There have been recorded negative consequences, such as weight gain, high blood sugar levels, dyslipidemia, and osteoporosis. Changes in overall nutritional status, such as weight gain, might sometimes be therapeutically desired, as in the case of megestrol, however for other drugs, such as

antipsychotics, it can be an unfavorable side effect. Weight gain, hyperglycemia, and dyslipidemia are just a few of the metabolic side effects that have been linked to second-generation antipsychotic treatment. When compared to first-generation antipsychotic medications, the use of a drug called quetiapine, and olanzapine significantly increased the likelihood of gaining weight (higher BMI), but the use of aripiprazole, ziprasidone, and clozapine considerably decreased the likelihood of weight gain. Increases in body size and body mass index (BMI) brought on by risperidone in nonobese people do not cause an expected alteration in lipid profile. Pharmacoeconomic studies indicate that there is no discernible difference in the development of diabetes between first- and the second generation antipsychotics. Other medications, including capecitabine, can lead to severe hypertriglyceridemia ( $> 500$  mg/dL), especially in people who are already at risk.

The impact of medications on the level of a specific mineral can also be complex. Drugs can affect how nutrients are distributed, metabolized, and excreted. The relevance of specific markers will play a role in determining the significance of alterations in nutritional status brought on by pharmaceutical use.

Any clinical manifestation could also be both drug- and patient-specific. As a result of an interaction, the emergence of a classic nutrient shortage condition would be seen as being exceedingly unlikely. Clinical signs may instead be linked to a less severe impairment. It is not a novel idea that some negative medication effects are directly linked to their impact on nutritional status. Whether dose-related, duration-related, or both, medication-induced nutritional deficits can be categorized as a subclass of negative pharmacological effects.

The breadth of the research on drug-nutrient interactions is based on a working definition of the problem is highly complex and calls for constant work at several levels. The inclusion of the following factors can enhance detection of drug-nutrient interactions at the most fundamental level. Issue covered in postgraduate training symposiums and courses for health care professionals. Additionally, it will be crucial to formally recognize medication-nutrient interaction at the level of medication creation and regulation. The categories of drug-nutrient interactions can be used as a framework during the course of drug development in order to produce data that will be helpful to physicians. It will involve the efforts of all physicians and researchers with a desire to enhance patient care. While other researchers assess interactions for their mechanism, clinicians examine drug-nutrient combinations for their clinical relevance.

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### **3.5 Effect of Food and Nutrient on Drug dose and Efficacy**

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Medication's impact on overall well-being might have multiple factors. Food consumption, digestion, and absorption can all be affected by drugs. A drug's immediate effect on the digestive system or the gut-brain axis may change how much food is consumed. Not much attention has been paid to the mechanism underlying the susceptibility of digestion to medications. When severe, gastrointestinal disturbances (such as stomatitis, nausea, vomiting, diarrhoea, and taste disorders) can make it difficult for people to preserve or improve their nutritional status. Alternately, drug-induced cognitive impairments, visual alterations, movement problems, and gait abnormalities, when severe, may have indirect impacts on food intake. Impaired capacity to get, prepare, or consume food may be a factor.

Efficacy is the ability to bring about a change (for example, lowering blood pressure). Only under ideal circumstances (i.e., when patients are chosen using the right criteria and faithfully follow the dose schedule) can efficacy be evaluated accurately. As a result, effectiveness is assessed under the guidance of an expert in a group of clients who are most likely to respond to a treatment, such as in an unbiased clinical study.

Effectiveness is distinct from the effectiveness in that it considers how well a medicine performs in actual use. A medicine that is effective in experiments is frequently ineffective when used as directed. For instance, a medicine may be highly successful at decreasing blood pressure but be ineffective because patients stop using it due to its severe side effects.

Effectiveness is distinct from effectiveness in that it considers how well a medicine performs in actual use. A medicine that is effective in research studies is frequently ineffective when used as directed. For instance, a medicine may be highly efficient at decreasing arterial pressure but be ineffective overall if individuals stop taking it due to the myriad of side effects it produces. If doctors unintentionally administer a drug improperly (for example, delivering a fibrinolytic to a patient who was supposed to be suffering from an ischemic stroke but actually had an undetected cerebral hemorrhage on a CT scan), effectiveness may also be lower than efficacy. As a result, effectiveness frequently falls short of efficacy.

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### **3.6 Effect of Nutritional status on Drug dose and Efficacy**

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The amount of medications that is supposed to be taken or given out is referred to as a "dose." (You might occasionally hear the phrase "dosage," meaning refers to a quantity of prescription given at particular intervals of time, such as once per day.) Separate doses of the same medication may be recommended for two separate patients. You shouldn't change the dosage of a drug you are taking without first talking to your doctor because calculating the correct amount demands accuracy.

Similar to patient-oriented outcomes, clinically important adverse effects include the following examples:

- **Death**
- **Disability**
- **Discomfort**

Although they are frequently utilized, surrogate adverse effects (such as altered serum marker concentrations) should, just like surrogate effectiveness results, preferably correspond actual patient-oriented adverse effects. If the duration of a negative impact is longer compared to the duration of a benefit or if the negative outcome is uncommon, clinical studies that are meticulously planned to demonstrate efficacy may nevertheless struggle to detect unwanted effects. For instance, cyclooxygenase-2 (COX-2) inhibitors swiftly reduce pain, making it possible to demonstrate their effectiveness in a fairly condensed amount of time.

Although it was not evident in shorter, smaller trials, the higher risk of myocardial infarction brought on by some COX-2 inhibitors appeared over a longer length of time. Because of this, and because some subgroups and high-risk individuals may not participate in clinical studies, harmful effects might not be completely understood until a medicine has been used extensively in clinical trials for years.

The balance between a drug's advantages and disadvantages determines whether it is recommended. Clinicians frequently weigh subjective elements such as individual anecdotes, peer practises, and expert opinions while making these decisions.

A less subjective calculation of the potential advantages of a medicine (or any other treatment) is the number required to treat (NNT). The total amount of patients that must be treated before one patient can benefit is known as the NNT. Consider a medicine that, for instance, reduces the mortality rate of a particular disease between 10% to 5%, representing an absolute decrease in risk of 5% one in 20). This suggests that 90 out of 100 patients would survive even without therapy, negating the need for the medication. In addition, 5 out of 100 patients will pass away despite taking the medication,

negating any advantage. The NNT is 20 because 20 people must be treated for everyone who benefits from the medicine, or 5 of 100 individuals (1 in 20). The reverse of the total risk reduction can be used to determine NNT; for example, if the absolute danger decrease is 5% (0.05), then NNT will equal 20. The quantity needed to cause damage (NNH) is another name for NNT, which can also be calculated for undesirable effects.

### 3.7 Let Us Sum Up

Drug interactions occur when a medicine is combined with other substances, changing how the medication affects the body. This could result in unanticipated side effects or lead the treatment to be either less or more effective than planned. You should be extra careful with your prescriptions if you take many prescription drugs, have specific medical conditions, or visit more than one doctor. You should also make sure that all of your doctors stay apprised of every medication, herbal remedy, nutritional supplement, and vitamin you are taking.

It's an excellent idea to discuss your medication regimen alongside your doctor or chemist, even if you only take one drug, to rule out any potential interactions. Both pharmaceutical and nonprescription medicines should follow this advice. Interactions between drugs are a frequent issue during medication therapy and result in a significant number of hospital admissions due to medically significant, occasionally dangerous, or even deadly side effects. The effectiveness of a treatment may be completely or partially eliminated as a result of medication interactions.

The risk of such interactions is increased by the ageing of the polypharmacy-prone European population, which emphasizes the significance of a rigorous awareness of the potential for interactions between drugs for all novel chemical entities. As a result of interactions among drugs that were only found after marketing, a number of medications have been taken off the market. A pharmaceutical product's benefit-risk assessment takes into account the possibility of drug-drug interactions, which can have a negative effect on this balance by raising the frequency of adverse events or decreasing efficacy.

This is the reason because of which each and every knowledge related to drug and its associated consequences should be known.

### 3.8 Answers to Check Your Progress Exercises

1. How exactly does this drug work in human body? What potential side effects could be experienced?

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2. Are there any specific foods or beverages that should avoid when taking this drug? If so, why?

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3. Can you also explain the signs of a drug interaction that should look out for?

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**BLOCK- II**

**Nutritional Support, Pathophysiology and Childhood Problems**

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## UNIT-4 : NUTRITIONAL SUPPORT

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### STRUCTURE

- 4.1 Introduction
- 4.2 Recent Advances in Techniques and Feeding Substrates
- 4.3 Let Us Sum Up
- 4.4 Check Your Progress Exercises

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### 4.1 Introduction

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Nutritional support is a therapy provided to individuals who cannot obtain adequate nutrition through normal eating or drinking. It aims to maintain or increase lean body mass and can involve various methods, including oral nutrition, enteral nutrition (feeding through a tube), or parenteral nutrition (feeding through an IV).

#### Types of Nutritional Support:

- **Oral Nutritional Supplements:** Fortified foods, additional snacks, and/or sip feeds can help increase calorie and nutrient intake.
- **Enteral Nutrition:** A nutritionally complete feed is delivered directly into the gut via a tube (e.g., nasogastric tube, feeding tube).
- **Parenteral Nutrition:** Nutrients are delivered directly into the bloodstream via an IV line.

Many undernourished patients need nutritional support. Nutritional support is aimed at maintaining or increasing the proportion of lean body mass. Oral feeding can be difficult for some patients with anorexia or with eating or absorption problems.

In this unit we will study about importance of Nutritional Support and Recent Advances in Techniques and Feeding Substrates in detail.

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### 4.2 Recent Advances in Techniques and Feeding Substrates

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Recent advances in feeding techniques and substrates include the use of closed enteral feeding systems, precision feeding in microscale bioreactors, and the application of advanced materials in food packaging. Additionally, there are significant advancements in using novel substrates like fermented feedstuffs and non-food raw materials for biofuels.

**Enteral Feeding:** Enteral nutrition is prescribed for people whose bowels remain functional, but who are unable to meet their **nutritional needs** with a normal **diet**. **Artificial feeding** has become an essential part of patient care in many settings: from hospitals to long-term treatment facilities to home care. **Recent advances in enteral nutrition technology and techniques** have made it easier and safer **to administer nutritional supplies**, helping to improve patient outcomes and quality of life.

- **Closed Systems:** These systems reduce the risk of contamination and infection by preventing exposure to the feeding tube or patient. One of the most recent advances in enteral nutrition is the use of closed systems. These systems allow the administration of nutrition without exposing the feeding tube or the patient to outside contaminants, thereby reducing the risk of infection and other complications.
- **Tube Feeding:** Advances in tube feeding include improved tube placement, continuous or

intermittent feeding, and the use of specialized feeding tubes like nasoduodenal and nasojejunal tubes.

### **Microscale Bioreactors:**

- **Fed-batch systems:** These mimic industrial processes and offer easy-to-setup substrate supply, often using diffusion- or enzyme-controlled feedings.
- **Automated systems:** These systems can respond to process deviations and provide precise and continuous feeding.

### **Food Packaging and Substrates:**

- **Nanomaterials:** The use of nanofibers as coatings for active food packaging improves its functional and structural properties.
- **Fermented Feedstuffs:** Fermentation can improve the nutritional quality, digestibility, and palatability of feedstuffs, potentially reducing feed costs.
- **Biofuels:** Second and third-generation biofuels, using non-food raw materials, offer a more favorable carbon balance and reduced environmental impact.

### **Other Advancements:**

- **Ultrasonication:** This technique is used for the extraction of various compounds.
- **SERS Substrates:** These are used for biosensing and food safety analysis.
- **Enzyme/Substrate Ratio:** Optimizing this ratio is crucial for enzyme-assisted extraction of bioactive compounds.
- **Biosensor Methods:** These are used for rapid and sensitive detection of analytes, including food-borne pathogens.
- **Mass Spectrometry:** This technique is used for the detection and quantification of various compounds, including food toxins.
- **Metabolomics:** This approach provides insights into the metabolic profiles of food, aiding in quality control and authentication.
- **Freeze-drying/Lyophilization:** This method preserves samples without heat damage

Recent advances in enteral nutrition focus on safer and more efficient delivery methods, as well as optimized feeding substrates. These include closed systems for reducing contamination, tailored feeding strategies for specific conditions like cancer or critical illness, and improved formulations to address specific nutritional needs.

### **Techniques:**

Recent advances in feeding techniques for patients, particularly in enteral nutrition, focus on improving safety, efficiency, and patient comfort. These advancements include closed systems, innovative connectors, and specialized tube placement techniques. Additionally, there's a trend towards more individualized feeding approaches, like bolus feeding, to better suit patient needs and preferences.

### **Closed Systems and New Connectors:**

- Closed systems minimize the risk of contamination by keeping the feeding tube and nutrition separate from external sources.

- New connectors, like those in the SimpLink™ system, offer greater flexibility and ease of use, potentially reducing feeding time and improving patient quality of life, especially for home enteral nutrition (HEN).

### Tube Feeding Innovations:

- **Bolus Feeding:** This method involves delivering nutrition in periodic, concentrated doses, offering benefits like reduced feeding time and improved patient comfort, particularly for mobile and active individuals.
- **Specialized PEG Tubes:** The introducer PEG, using a balloon catheter, has been refined to improve safety and address issues like stomach wall deflection during placement.
- **Balloon Gastrostomy Tubes:** These tubes are increasingly being used as a primary tube of choice in certain patient populations, like those with head and neck cancer, offering advantages after dislodgement of conventional tubes.

### Improved Tube Placement Techniques:

- **Endoscopic Directed Access:** This method allows for precise and safe tube placement for various feeding needs, including nasoenteric tubes, percutaneous endoscopic gastrostomy (PEG), and percutaneous gastrojejunostomy (PGJ).
- **Double Gastropexy with a Peel-Away Sheath:** This technique provides secure fixation of the stomach wall during PEG placement, similar to surgical gastropexy.

### Focus on Patient Needs and Preferences:

- **Individualized Feeding Plans:** Recognizing that patients have diverse needs, feeding plans are increasingly tailored to factors like age, underlying disease, and patient preferences.
- **Complementary Feeding:** Bolus feeding is often used to supplement an oral diet, allowing patients to maintain a sense of normalcy and social integration.
- **Closed Systems:** These systems minimize the risk of contamination by preventing external elements from entering the feeding tube or patient. One of the most recent advances in enteral nutrition is the use of closed systems. These systems allow the administration of nutrition without exposing the feeding tube or the patient to outside contaminants, thereby reducing the risk of infection and other complications.
- **Trophic Feeding:** A strategy involving low-volume, nutrient-rich feeds, particularly beneficial in the early stages of critical illness to minimize the negative effects of fasting or overfeeding.
- **Customized Feeding Strategies:** Adjusting feeding methods (continuous, bolus, gravity) and tube types (nasogastric, nasoduodenal, nasojejunal) based on the individual patient's needs and medical condition.

### Feeding Substrates:

Feeding substrates are the essential nutrients provided to patients, especially those unable to eat normally, to meet their nutritional needs. They can be delivered through enteral or parenteral routes. Enteral nutrition, like tube feeding, uses the digestive system, while parenteral nutrition bypasses it with intravenous delivery.

## Enteral Nutrition

- **Tube Feeding:** Nutrients are delivered directly into the stomach or small intestine via a tube (Nasogastric, Nasoduodenal, Nasojejunal).
- **Oral Supplements:** When patients can swallow but need extra calories or nutrients, they may be given oral nutritional supplements.
- **Commercially Prepared Formulas:** These formulas provide a balanced mix of carbohydrates, proteins, and lipids, often in a liquid form.
- **Carbohydrates:** Maltodextrin is a common carbohydrate source, providing 4 kcal/g, and is well-tolerated by patients.
- **Proteins:** Casein, lactalbumin, and soy protein are examples of protein sources used in formulas.
- **Lipids:** Fat emulsions and oils (including MCT) are used to increase energy and essential fatty acids in the diet.

## Parenteral Nutrition

- **Intravenous Delivery:** Provides nutrients directly into the bloodstream, bypassing the digestive system.
- **Total Parenteral Nutrition (TPN):** Provides all essential nutrients, including calories, protein, carbohydrates, and micronutrients.
- **Peripheral Parenteral Nutrition (PPN):** Delivers nutrients through peripheral veins, often used for short-term needs.
- **Nutrient Composition:** TPN solutions contain dextrose (for carbohydrates), amino acids (for protein), and lipids (for fats), along with electrolytes, trace elements, and vitamins.

## General Considerations

- **Individualized Needs:** Nutritional needs vary based on age, health status, and specific conditions.
- **Monitoring:** Patients receiving nutritional support should be monitored closely for any complications, including electrolyte imbalances, dehydration, or hyperglycemia.
- **Transitioning to Oral Intake:** When appropriate, patients should be transitioned back to oral feeding gradually to promote gut health and function.
- **Optimized Protein Intake:** Research suggests that adequate protein supplementation, especially in critically ill patients, can improve prognosis, with the optimal timing and dosage varying depending on the patient's condition.
- **Specialized Formulations:** Formulations tailored for specific conditions, such as cancer or inflammatory bowel disease, are being developed to address unique nutritional needs.
- **Microbial Gut Health:** Focus is increasing on the role of the gut microbiome in health and disease, with feeding substrates potentially modified to support beneficial bacteria and minimize harmful ones.

## Examples of advancements:

- **Closed systems:** Reduces the risk of infection and contamination during feeding.

- **Trophic feeding:** A strategy that provides a minimal level of nutrition to stimulate the gut without causing overfeeding.
- **Customized feeding strategies:** Selecting the most appropriate feeding method and tube type for the patient's specific needs, such as in cancer patients.
- **Specialized formulas:** Formulations that meet the unique needs of patients with conditions like cancer or inflammatory bowel disease.

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## 4.3 Let Us Sum Up

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Recent advances in feeding techniques, particularly in enteral nutrition, are crucial for patient outcomes due to their improved safety, precision, and adaptability. These advancements can lead to better nutritional status, reduced complications, and improved overall health for individuals who need specialized feeding support.

- **Improved Safety and Reduced Complications:** Advancements like closed enteral feeding systems minimize the risk of contamination, reducing the incidence of infections and other complications associated with tube feeding. The use of specialized connectors like ENFit also helps prevent misconnections, ensuring safe and accurate delivery of nutrition and medications.
- **Enhanced Precision and Adaptability:** Modern enteral tube pump technologies allow for more precise and adaptable delivery of nutrition, tailoring the feeding regimen to individual patient needs. This can be particularly important for critically ill patients who require precise control over their nutrient intake.
- **Improved Nutritional Outcomes:** Effective enteral nutrition can counteract the metabolic changes associated with critical illness, helping patients maintain a healthy nutritional status and improve their overall health. Adequate nutrient delivery through enteral feeding also supports immune function and wound healing.
- **Enhanced Clinical Workflows:** The use of closed systems and advanced pump technologies can streamline clinical workflows, making it easier for healthcare professionals to manage enteral nutrition support. This can improve efficiency and reduce the workload on healthcare providers.
- **Benefits for a Wider Range of Patients:** Enteral nutrition is increasingly used for a broader range of patients, including those with neurological conditions, cancer, and other conditions that impair their ability to eat or drink normally. Advancements in feeding techniques have made enteral nutrition more accessible and effective for these patients.

In summary, recent advances in feeding techniques have significantly improved the safety, precision, and adaptability of enteral nutrition, leading to better nutritional outcomes, reduced complications, and improved clinical workflows for a wider range of patients.

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## 4.4 Check Your Progress Exercises

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### 4.4.1 What are the improved tube placement techniques?

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**4.4.2 Explain the importance of recent advances in techniques and feeding substrates?**

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**4.4.3Elaborate theimproved tube placement techniques?**

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## **UNIT-5 : Pathophysiology, Metabolic & Clinical Aberrations, Complication Preventions and Recent advances in Medical Nutritional Management**

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### **STRUCTURE**

- 5.1 Introduction
- 5.2 Weight Imbalances
- 5.3 Cardiovascular Disorder
- 5.4 Diabetes Mellitus
- 5.5 Other Metabolic Disorder
- 5.6 GI Tract Disorder
- 5.7 Liver & Gallbladder Disorder
- 5.8 Pancreatic Disorder
- 5.9 Renal Disorder
- 5.10 Stress & Trauma Causing Cancer
- 5.11 Neurological Disorder
- 5.12 Musculoskeletal Disorder
- 5.13 Immune Deficiency Disorder
- 5.14 Genetic Disorder
- 5.15 Infections
- 5.16 AIDS
- 5.17 Respiratory Problems
- 5.18 Let Us Sum Up
- 5.19 Glossary
- 5.20 Check Your Progress Exercises

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### **5.1 Introduction**

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The metabolic disorder (MetS) is a collection of metabolic disorders that includes thermogenic dyslipidaemia, hypertension, central obesity, and insulin resistance. The risk for developing atherosclerosis cardiovascular disease (CVD) is significantly raised by MetS. Both inherited and acquired variables that contribute to the ultimate inflammatory cascade that results in CVD are involved in the pathophysiology of MetS. Because of the global epidemic of obesity, MetS has recently gained more significance. In order to successfully implement lifestyles and risk factor modification, early diagnosis is crucial. Antihypertensive, statins, which and metformin are a few examples of the medications used in pharmaceutical therapy for MetS. It has been demonstrated that various natural substances and dietary components, often known as nutraceuticals, can help cure MetS. In this article, we examine the epidemiology and aetiology of MetS, the function of inflammatory in MetS, and a summary of the natural treatments now available for MetS.

The risk for both atherosclerosis and nonatherosclerotic CVD is raised by MetS. It is still debatable perhaps the risk is the sum of its constituent parts or whether the grouping of these parts results in a synergistic danger. According to Motillo and colleagues' most recent meta-analysis, MetS increases the risk of CVD events and raises the overall mortality rate by 1.5 times. MetS management involves a dual strategy that combines pharmaceutical and lifestyle therapies in an attempt to reduce CVD. The multifactorial condition known as metabolic syndrome (also known as syndromes X, or insulin resistance) is brought on by insulin resistance together with aberrant adipose accumulation and function. It combines risk factors for type 2 diabetes, fatty liver, various malignancies, coronary heart disease, and other conditions. The multifactorial condition known as metabolic syndrome (also known as syndromes X, diabetes, and insulin resistance) is brought on by insulin resistance together with aberrant fat deposition and function. It combines risk factors for diabetes, liver fatty tissue, various malignancies, coronary heart disease, and other conditions.

In this unit you will study about various deficiency diseases & disorders, about their pathophysiology and required nutritional management.

### **OBJECTIVE:**

1. Students will be able to understand the pathophysiology & clinical aberration of various metabolic disorders.
2. Students will learn about the nutritional management of various diseases.

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## **5.2 Weight Imbalances**

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Obesity is frequently attributed to either excessive food consumption or a lack of physical activity. There is a lot of discussion concerning which conduct merits. However, this strategy hasn't yet led to any successful or ground-breaking solutions. We think that considering obesity as a matter of energy balance is the most useful. According to the first law of thermodynamics, if energy intake and expenditure are equal over a certain period of time, body weight cannot vary. This line of reasoning assigns responsibility to both behaviours rather than just one and the other. If there are too many people who are in an energy balance that is favourable, then altering both energy consumption and energy expenditure is necessary to achieve balance. Understanding how the body achieves energy balance could be helpful in developing measures that effectively lower obesity rates.

The energy balance framework's analysis of lowering obesity gives us the chance to suggest particular obesity-reduction tactics. First, by boosting physical activity levels, we can maximise the inherent biological processes for maintaining energy balance and bring more people into the controlled zone of energy balance. By doing this, we would be able to concentrate on encouraging smarter consumption and would no longer require drastic food restrictions. Second, due to the elements of energy balance compensating to fight weight loss in reaction to a negative energy balance, we are probably going to be more successful in preventing gaining weight than in achieving and maintaining weight loss.

### **5.2.1 PATHOPHYSIOLOGY OF WEIGHT IMBALANCE**

Environmental, behavioural, psychological, and physiological influences. These elements, along with the pleasure eating gives us (hedonic elements), can all affect energy balance, which can result in weight gain. Once established, strong neuro-hormonal defences against weight loss effectively protect the body, making obesity a chronic condition where weight gain (or return) is more common than not.

To understand the science of obesity, one must first understand energy balance. The pathophysiology of being overweight is influenced by altered energy balance. If total energy taken in

(through food and drink consumption) surpasses entire body energy expenditure in healthy persons without malabsorption problems, the body's reserves of stored energy rise.

Adaptive thermogenesis, basal metabolism, and physical activity are all ways that the body uses energy. Complex homeostatic processes in the body work to prevent weight gain and decrease. Initially, overly simplified beliefs said that actions of will and food availability caused obesity. But there are several biochemical processes connected to energy imbalance that cause obesity. These include the central nervous system's influence on behaviours like eating and exercise, as well as the neuroendocrine system's control over the release of hormones including leptin, insulin, oestrogen, and growth and thyroid hormones.

Our bodies are designed to react to weight loss by gaining weight. Metabolic adaptation is the term used to describe how weight loss affects the body's equilibrium system, which regulates appetite, energy intake, and energy expenditure, leading to an increase in hunger and a decrease in metabolic rate.

### **Obesity's effects on the brain**

In terms of obesity and energy balance, the nervous system's function is highly significant. The neurobiology of being overweight is primarily influenced by three regions of the brain. The hypothalamus is located in the mesolimbic region, and the executive function regions are these.

- **Homoeostasis and the hypothalamus**

The hypothalamus uses homeostatic mechanisms to regulate feeding. The hypothalamus is located in the centre of obesity, which develops when there is a discrepancy among calorie consumption and energy expenditure. Under typical conditions, the hypothalamus receives peripheral information to centrally maintain long-term energy balance. Changes in these sensory signals, along with other elements including inheritance and the effects of drugs, may contribute to the imbalance between energy intake and expenditure.

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- **The executive function and the prefrontal cortex**

The higher cognitive especially executive control functions of the prefrontal cortex include controlling emotions, impulses, wants, and appetites, particularly those related to eating. The behavioural and reward-cue based stimulation of the mesolimbic system can often be countered by this region. The mesolimbic system, however, is dampened down in stressful circumstances in favour of the prefrontal cortex, which enhances innate survival responses like food hypervigilance. Acute and long-term stressors both lead to an increase in synaptic branches in the amygdala while decreasing synaptic connections to the prefrontal cortex. In this way, with prolonged stress, a brain network favouring mesolimbic responses emerges.

### **The role of hormones in the study of obesity**

Leptin, the hormone insulin, oestrogens, growth hormone, and thyroid hormones are among the hormones that are thought to play a role in the science of obesity. By affecting appetite, metabolism, and the distribution of body fat, altered amounts of those hormones can promote obesity and impede

weight loss in people who already have the disease.

- **LEPTIN**

Leptin By limiting food intake and lowering one's desire for palatable foods, leptin, which is produced via adipose tissue, works in the brain's hypothalamus in order to avoid weight gain. Although circulating leptin levels are higher in obese individuals, this does not prevent them from overeating. Dieting, or restricting one's intake of food, is a typical strategy for attempting to prevent overweight. However, when the restriction expires, the reduced weight is frequently followed by compensatory growth, which can lead to obesity. The efficacy of the leptin signal may be a major determinant of whether obesity develops.

- **INSULIN**

Insulin levels are correlated with the balance of energy and go up with obesity and down with famine. Through its effects on skeletal muscle, the liver, and adipose tissue, insulin is a crucial hormone involved in maintaining glucose homeostasis. Neuropeptide Y, which promotes gain of weight through increased eating and lower energy expenditure, is suppressed by insulin in the brain. Consequently, insulin can prevent weight gain. An individual is said to be insulin resistant when higher levels of circulating insulin are required to maintain glucose homeostasis. Numerous investigations on the molecular causes of diabetes of the type 2 variety have shown that insulin resistance, which can cause the disease, is mediated by chronic low-level inflammation in people who are obese.

- **OESTROGEN**

Compared to premenopausal women, menopausal women are three percent more likely to become obese. Oestrogen levels falling during menopause are a major factor in menopausal women becoming obese. In addition to changing the lipid makeup of post-menopausal women, the deficiency of oestrogen also promotes a predominance of belly fat storage. In fact, a meta-analysis of more than 100 controlled studies in postmenopausal women that examined the impact of replacement hormone therapy (HRT) that included oestrogen on the metabolic syndrome's component diseases discovered that HRT containing oestrogen boosted lean body mass, decreased abdominal fat, and enhanced insulin resistance.

- **Both Thyroid Hormones And Growth**

In both children and adults, growth hormone increases growth. Its primary function is to control metabolism. Obesity blunts growth hormone production of oil, both naturally occurring and that elicited by stimulation. Although the pathophysiologic mechanism of growth hormonal in obesity is not fully understood, giving growth hormone to obese people has been associated with obesity loss and improved metabolism of lean body mass.

Similar to this, obesity frequently results in the dysregulation of thyroid hormones. Obese people frequently have sub-clinical hypothyroidism with high TSH and borderline peripheral thyroid hormone levels.

## **5.2.2 EFFECTIVE AND NUTRITIONAL MANAGEMENT OF OBESITY**

People who are obese find it difficult to maintain weight loss, and research such as the Actions IO study\* demonstrates that willpower isn't the cause of obesity. We must take into account the physiological, psychological, and biological aspects of obesity in order to choose the most effective management options. Although modifying one's diet and exercise remain essential in controlling the symptoms of obesity, patients increasingly need pharmaceutical adjuncts to help them lose weight or keep it off. It is also critical to comprehend the various systems that contribute to the

pathophysiology of obesity, as therapies to address these systems may be necessary to achieve long-lasting weight loss.

It can be difficult for many people to understand what it means to control their body mass index, what a normal weight is, and the best ways to prioritise their health and wellbeing. Numerous diverse variables might contribute to confusion, and contradicting information regarding many important topics only makes matters worse.

The process of making long-term adjustments to your lifestyle in order to preserve an appropriate weight for your age is typically referred to as weight management. These lifestyle adjustments can take many forms, but frequently involve eating your healthier, better-rounded diet, engaging in more frequent and/or intense physical activity, and changing your perspective towards the use of food as an incentives, treat, or means of coping.

Finding your healthy weight is a crucial component of weight management. In order to fall inside what is regarded as a healthy range based on your height, years of age, and sex, you might want to make certain modifications, and this can help you determine whether you need to lose weight or gain it.

Determining your BMI is one of the methods you may use to find out if your weight is healthy. This can assist in determining whether your weight is healthy for your height, age, and sex. Although this approach may not be beneficial for everyone, for instance, if you have more muscle mass than normal, it is thought to be rather accurate in determining a healthy weight.

You can use a variety of weight-management techniques to help you succeed over the long run. Both the long- and short-term benefits of working alongside a nutritionist or other dietary specialist can be realised. A specialist can assist you in a variety of ways, such as:

- **Decide to change:** Making the decision to change can be among the most crucial first steps. You can adjust your thinking away from focusing solely on the scales and towards how you would like to achieve and keep up a healthy, sustainable way of life by acknowledging that you are committed to making continuous lifestyle changes. Partnering with a pro can be a terrific first step to committing to something and taking action.
- **Make a list of your current routines.** Sometimes we are unaware of our harmful practises. Working with someone with expertise can help us make a note of our insufficient behaviours while demonstrating new ways we are noticing them in our daily lives. This may be the case whether it is not incorporating enough physical activity through our routines, practising poor sleep hygiene, or dependent on food to help increase our mood and energy levels.
- **Set attainable objectives and benchmarks.** Big ambitions might occasionally serve as motivation. Asking for too many improvements at once, though, can occasionally become overwhelming and demoralising. Setting more manageable goals can be facilitated by working with a professional. This will enable you to see development and experience success much quicker, which can inspire you.
- **They will adjust their strategy to best meet your needs.** Everybody has a different type of body, metabolism, and set of needs. When you work with a nutritionist, they can take into account your unique situation, needs, and demands. These may cover important topics like:
  - Do you require to put on, take off, or keep on weight?
  - Do they have any dietary restrictions in particular? (Allergies, pescatarian, vegetarian, vegan).
  - What kind of exercise do you currently do? Does it need to be more frequent, more

intense, or more varied? Do you need to alter your calorie intake to support this?

- Your lifestyle, physique, and metabolic rate.

### 5.2.3 CLINICAL SIGNIFICANCE

The metabolic equilibrium of several organ systems is preserved. A few of these include muscles and adipose tissue. Adipocytes secrete adipokines, which are hormones or substances that act on various organs and cells to control metabolism. To better understand the levels of these hormones in various populations, such as the elderly and overweight/obese persons, as well as the role these hormonal play in obesity, more research is required. To gain a better understanding of how adipokines/hormones are regulated and their pathophysiology, it is also crucial that one comprehends how lifestyle decisions like dietary changes, consistent exercise (aerobic especially resistance), vitamin supplementation, or a combination of every one of these actions affect adipokine/hormone concentrations.

All medical practitioners working to prevent obesity should have an improved knowledge of the pathogenesis of obesity. An interprofessional healthcare team, including doctors, nurses, experts in nutrition, dieticians, and exercise physiologists, must be included in patient treatment in order to control and prevent obesity.

Given that obesity is a disorder of the immune system and a chronic poor-quality inflammatory condition, and that the inflammatory markers released by an obese person's adipose tissue either cause or worsen other chronic diseases like diabetes, hypertension, dyslipidemia, and cancer, prevention is always preferable to treatment. The interprofessional team must inform patients about diet and exercise as a way of life in order to prevent obesity. Each interprofessional member of the team, including doctors, mid-level professionals, nurses, dietary professionals, and pharmacists, have to do this for it to be successful.

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## 5.3 Cardiovascular Disorder

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The heart and its blood arteries make up the cardiovascular system. The cardiovascular system can experience a wide range of issues, some of which include the condition known as end rheumatic coronary artery disease, and irregularities in the conduction system. Coronary artery disease (CAD), also known as coronary cardiomyopathy, stroke, cerebrovascular disease, arterial disease of the legs (PAD), and arterial atherosclerosis are the four conditions that make up cardiovascular disease, often known as heart disease. Myocardial infarction (MI) and/or heart failure can occur as a result of myocardial ischemia, which occurs in angina owing to CAD. One-third to fifty percent of every instance of cardiovascular disease are caused by it. Temporary ischemic attacks (TIAs) and strokes are both conditions characterized by a condition known as cerebrovascular disease.

Peripheral arterial disease, also referred to as PAD, is an arterial condition that typically affects the limbs and can cause claudication. The condition connected to thoracic and abdomen aneurysms is aortic atherosclerosis. This exercise examines the diagnosis, prognosis, and involvement of the medical staff in the evaluation and management of cardiovascular illness.

The heart and blood arteries make up the cardiovascular system. The cardiovascular system can experience a wide range of issues, including a condition called end rheumatic heart disease, irregularities in the conducting system, and coronary artery disease (CVD) or the heart disease, among others. Pertain to the four subjects of this article, which are as follows:

- Angina, myocardial infarct (MI), and/or heart attack are all symptoms of coronary artery disease (CAD), which is also known as coronary artery disease (CHD). It is responsible for

between one-third and fifty percent of CVD cases.

- Temporary ischemic attack (TIA) and stroke are two examples of cerebrovascular disease (CVD).
- Peripheral arteries disease (PAD): An arterial condition that affects the limbs and may cause claudication.
- Including pulmonary and abdominal aneurysms is aortic atherosclerosis.

### **5.3.1 PATHOPHYSIOLOGY OF CARDIOVASCULAR DISEASES**

Atherosclerosis is a disease-causing process that develops in the coronary arteries and aorta and results in diminished or nonexistent blood flow as a result of blood vessel stenosis.

It is influenced by a number of variables, including dyslipidemia, immune system events, inflammation, and dysfunction of the endothelial system. These elements are thought to be the starting point for the progressive development of the fatty stripe, which is the characteristic of the plaque caused by atherosclerosis and can start as early as childhood. This process includes intimal thickening, followed by a buildup of extracellular matrix and lipid-rich macrophages (foam cells), smooth muscle cell aggregation, and smooth muscle cell proliferation, which results in the creation of the atheroma plaques. Apoptosis inside the deep layers may occur when these lesions grow, triggering more macrophage recruitment.

### **5.3.2 CLINICAL SIGNIFICANCE**

The hallmarks underlying the diagnosis of CVD include an extensive medical history and a physical examination that includes but is not limited by the cardiovascular system. Particularly, a history suggestive of obesity, angina, decreased capacity for exercise, orthopnea, paroxysmal nocturnal or dyspnea, convulsions or presyncope, and feeling confined ought to prompt the clinician to conduct a more thorough history and physical examination and, if necessary, order ancillary diagnostic tests in line with the clinical situation (e.g., an electrocardiogram (ECG) and cardiac enzyme testing for patients presenting alongside chest pain).

The majority of efforts should be focused on primary prevention by focusing on those who have risk factors and treating modifiable risk factors using all available tools, in addition to a diagnosis indicated by clinical suspicion. Beginning at age 20, every patient should participate in the conversation about CVD indicators and cholesterol testing.

Prevention strategies including maintaining a healthy weight, avoiding obesity, and leading a physically active existence are important for all patients, but they are more important for those who have risk factors that cannot be changed, like a family history of early CHD or menopause. The inflammatory markers along with additional evaluation of risk techniques, such as the coronary artery calcium production score (CAC), are still being studied and have only a few applications, so they shouldn't be used to replace the detection of those with known risk factors. Nevertheless, these resources continue to hold promise for the primary prevention of CVD in the future by identifying those with subclinical cardiovascular disease at risk.

### **5.3.3 NUTRITIONAL MANAGEMENT OF CARDIOVASCULAR DISEASES**

Globally, cardiovascular illness is the leading cause of mortality, according to the WHO. Coronary artery disease, cerebrovascular illness, rheumatic heart disease, and other ailments are among a category of disorders of the heart and blood arteries. Diet and lifestyle are crucial for preserving heart health. An unhealthy diet can increase a person's likelihood of cardiovascular illness and set off additional risk factors that may result in heart disease. A healthy eating habit is more beneficial than a specific diet at reducing the risk developing heart disease. Although some cardiac

anomalies, such as congenital heart problems, cannot be prevented, dietary adjustments and a change in lifestyle can assist.

### **A balanced diet promotes heart health.**

- Carbohydrate intake is moderate. Primarily whole grain cereals, such as quinoa, wheat, oats, millets, etc. These are excellent sources of vitamins, particularly vitamin B complex, which lowers the risk of heart disease and lowers the morbidity and mortality from stroke. Minerals and vitamins also aid the contraction of the heart muscle, which absence may result in heart problems.
- A diet that is both healthy and well-balanced must include protein. Egg, fish, poultry, legumes, milk, and milk products are sources. It assists in lowering blood pressure, maintaining a healthy weight, and lowering cholesterol. To maintain a healthy heart, however, red meat and other proteins high in saturated fat must be avoided.
- In a typical diet, fat must be present in some quantity. The greatest cooking oils for heart health are those that include PUFA (polyunsaturated fatty acids) and MUFA (monounsaturated fatty acids). Numerous studies have demonstrated that while MUFA helps to lower LDL (low density lipoprotein) cholesterol levels while maintaining HDL (high dense lipoprotein) cholesterol levels, PUFA helps to minimize CVD risk. Canola oil, the seeds of sesame oil, and peanut oil are PUFA-rich oils. Sunflower oil, olive oil, and other oils are MUFA-rich.
- Fruits and vegetables play a crucial part in maintaining excellent health. These are excellent providers of vitamins and minerals, which are crucial for maintaining the health of our hearts. By neutralizing radicals called free radicals, which may play a major part in the development of atherosclerosis and CVD, vitamins, particularly those with antioxidant strength like vitamin C, E, and carotenoids, are able to reduce the extent of oxidative stress that occurs.
- Dehydration can harm the body's organs and physiological processes, particularly the cardiovascular system. Dehydration causes the body's blood flow to decrease, which causes the heart to beat more quickly and raise blood pressure and heart rate as a result. Therefore, it is imperative to consume at least five ounces of water each day.

### **Dietary guidelines for people with heart disease**

- A healthy weight, under control blood pressure, and cholesterol levels can all be achieved by increasing the fibre in your diet.
- Heart disease can be brought on by improper blood sugar management. Patients with diabetes should adhere to a strict eating plan to keep their blood sugar levels in check and save their hearts.
- Sodas and other carbonated drinks should be avoided since they provide empty calories that increase cholesterol, blood pressure, and body weight.
- Alcoholism in excess causes harmful cholesterol to build up.
- Daily consumption of water should be monitored in cases of heart failure since too much fluid in the bloodstream makes it more difficult for heart muscle to pump.
- High salt intake can cause blood pressure to increase, which is an important risk indicator for cardiac issues. So it is important to monitor salt intake. If sodium consumption cannot be avoided, knowing the amount of sodium in packaged and processed foods will be helpful.

The best way to maintain a healthy heart is by regular exercise, sound sleep habits, a stress-free lifestyle, and a heart-friendly diet.

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## 5.4 Diabetes Mellitus

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When the amount of glucose in your blood is too high, you develop diabetes. It happens when your body doesn't process insulin effectively or when your pancreas doesn't produce any insulin at all. All ages are impacted by diabetes. Diabetes comes in a variety of forms, the majority of which are chronic (lifelong) and treatable with medication and/or dietary modifications. Carbohydrates in your meals and beverages are the main source of glucose (sugar). It is the primary energy source for your body. All of the cells in your body receive glucose from your blood to be used as fuel.

When hypoglycemia is in the blood stream, it needs assistance—a "key"—to get to where it needs to go. Insulin is the key, a hormone. Hyperglycemia, or high blood sugar, results from the bloodstream's accumulation of glucose, which can happen if your pancreas doesn't produce a sufficient amount of insulin or your organism doesn't use it properly. Consistently high blood sugar levels over time can lead to health risks like heart disease, nerve damage, and vision problems.

Diabetes mellitus is the correct medical term for the condition. The name "diabetes" is also used to describe another ailment, called diabetes insipidus, however it is a separate condition. Because they both result in more thirst and frequent urination, they are both referred to as "diabetes". Unlike diabetes mellitus, diabetes insipidus is far less common.

The various forms of diabetes. The most typical forms consist of:

- Type 2 is a type of diabetes: With this form, your body either doesn't produce enough insulin or the cells don't react to it properly (insulin resistance). The most typical form of diabetes is this one. Although mostly affecting adults, it can also impact kids.
- Prediabetes: The stage of diabetes before Type 2 is this type. Your levels of blood glucose are above average but not sufficiently elevated to receive a Type 2 diabetes diagnosis.
- Type 1 diabetes is an autoimmune condition in which, for an unidentified cause, your immune system targets and kills cells that produce insulin in your pancreas. Type 1 diabetes affects as many as ten percent of patients with the disease. Type 1 diabetes affects as many as ten percent of patients with the disease. Although it can occur at any age, it usually receives a diagnosis in young kids and teens.
- Gestational diabetes: Some women experience the onset of this type while pregnant. After pregnancy, gestational diabetes typically disappears. The chance of acquiring Type 2 diabetes subsequently in life is increased if you're diagnosed with gestational diabetes, though.

**Additional forms of diabetes include:**

- **Subtype 3c diabetes:** This type of diabetes develops when your pancreas sustains injury that impairs its capacity to make insulin (damage unrelated to autoimmune disease). Damage to the pancreas that results in diabetes can be brought on by pancreatitis, pancreas cancer, cystic fibrosis, and hemochromatosis. Type 3c can also arise from having the pancreatic gland removed (pancreatectomy). Adults with latent autoimmune diabetes (LADA): LADA is caused by an autoimmune reaction, just as Type 1 diabetes, although it progresses considerably more slowly. Those who are diagnosed as LADA are often older than 30.
- A genetic abnormality that changes how your body generates and uses insulin causes

diabetes with the onset of the young (MODY), also known as monogenic diabetes. MODY now comes in more than ten different varieties. Up to 5% of diabetics might develop it, and it frequently runs in families.

- **Neonatal diabetes:** During the first twelve weeks of life, this unusual form of diabetes develops. It also has a monogenic diabetes subtype. The lifelong form of neonatal diabetes known as persistent neonatal diabetes mellitus affects about 50% of newborns. The illness vanishes for the second half after a few months of beginning, but it may recur later in life. Transient neonatal diabetes with complications is the term used for this.
- **Brittle diabetes** as a type of diabetes known as type 1 characterised by frequent, significant spikes and falls in blood sugar levels. Hospitalisation is frequently a result of this instability. Rarely, brittle diabetes may require a pancreas transplant to be permanently treated.

#### 5.4.1 PATHOPHYSIOLOGY OF DIABETES MELLITUS

The body's ability to use insulin and the quantities of insulin present are factors in the pathophysiology of diabetes. In diabetes of type 1, there is no insulin at all, whereas in diabetes with type 2, peripheral tissues are resistant to the actions of insulin. Normally, elevated blood glucose levels induce pancreatic beta cells to produce insulin. Glucose is constantly needed by the brain to function properly for proper activities to take place. Drugs used to treat diabetes, such as insulin and oral antihyperglycemics, commonly produce a state of hypo or low plasma glucose levels. Plasma glucose concentrations in diabetes signal the nervous system's decision to release stored energy, according to the pathophysiology of the disease. It is based on factors including arterial blood sugar levels, the rate at which plasma glucose levels fall, and other accessible metabolic fuels. It also takes into account the health of the brain's tissues and blood flow.

Diabetes has a complicated pathophysiology that involves a number of hormones, including glucose, glucagons, Insulin and growth hormone. The pathogenic processes of this disease are hard to nail down and vary greatly between patients due to the interplay of these chemicals with the liver's functions and their part in renal function. More in-depth descriptions of this pathophysiology can be obtained. Diabetes has a decreased ability to absorb glucose, regardless of its underlying aetiology. Genetic predisposition factors including abdominal obesity mediate insulin resistance.

There is still more to be uncovered regarding the underlying causes of diabetes mellitus, as we are finding out. Diabetes mellitus is an autoimmune phenomenon characterised by abnormal glucose metabolism and excessive hyperglycemia that can be brought on by either a lack of secretion of insulin or by a concomitant mixture of resistance to insulin and insufficient insulin production. People with type 1 diabetes are more likely to develop ketoacidosis because their pancreatic islet B cells are being destroyed mostly an autoimmune mechanism. The more common form of diabetes, type 2, is caused by resistance to insulin with a failure in compensating insulin secretion. Serious complications from diabetes can arise in a variety of illnesses or conditions that impact many different body systems and may cause early mortality.

The pancreas, which is an organ situated below the liver & stomach, secretes enzymes for digestion as well as the hormones glucagon and insulin into the circulatory system in order to regulate the body's glucose levels in healthy individuals. By allowing hypoglycemia to enter body cells where it is metabolised, the introduction of adrenaline into the circulation lowers the amount of glucose in the blood (simple sugars from diet). The pancreas releases glucagon to encourage the liver's release of glucose if the blood sugar levels go too low. Blood glucose levels spike immediately following a meal because both carbohydrates and amino acids penetrate straight into the bloodstream. Important pancreatic cells known as beta cells are prompted to secrete insulin as blood glucose levels rise, crucial pancreatic cells known as beta cells secrete insulin, which is released into the bloodstream.

Insulin reaches its maximal level Twenty minutes after a meal.

Glucose can enter body cells with the help of insulin, especially liver and muscle cells. In this situation, insulin along with various hormone control whether or not glucose will be used immediately for energy or kept for later. High amounts of insulin cause the liver to cease generating glucose and instead store it until the human body demands it again. The pancreas decreases the synthesis of insulin as the blood glucose levels peak (approximately 2 to 4 hours after a meal, both blood sugar as well as insulin are at modest levels).

Food is divided into smaller parts before being consumed. In order for the human body to use sugars and other carbs as a source of energy, they must first be converted into glucose. Glucose can also be produced by the liver.

The amount of glucose in the blood is controlled in healthy individuals by a hormone called insulin, which is produced by the pancreatic beta cells. Insulin encourages cells to take up enough glucose from the blood to provide them with the energy they require when there is an excess glucose in the blood. Additionally, insulin encourages the liver to take in and store any extra glucose in the blood. When blood glucose levels increase after a meal, insulin is released, for instance, insulin levels decrease with physical activity.

Insulin resistance and decreased insulin secretion are two characteristics of type 2 diabetes that can both be altered by hereditary and environmental factors. The relative importance of decreased insulin production and insulin resistance to the onset of diabetes has been the subject of much debate. Prior to a few years previously, it was widely believed that diabetes-related insulin resistance, instead of decreased  $\beta$ -cell activity, was the main genetic contributing factor. Despite the fact that insulin resistance is undoubtedly a significant contributing factor, the evidence at hand suggests that it is neither a necessary nor the primary hereditary factor.

Obesity (especially boosted visceral fat), lack of activity, high-fat diets, the adverse consequences of high blood sugar levels (glucose toxicity), and raised circulating levels of liberated fatty acids (lipotoxicity) can be blamed for the majority of insulin resistance that's observed among those who have type 2 diabetes.

#### **5.4.2 CLINICAL SIGNIFICANCE**

Type 1 diabetes, type 2 diabetes, hybrid kinds of diabetes, hyperglycaemia initially discovered during pregnancy, "unclassified diabetes," and "other specific types" are the six types of diabetes mellitus. "Hybrid kinds of diabetes" comprise adult-onset, immune-mediated diabetes including ketosis-prone diabetes of the type 2 variety. The term "hyperglycaemia initially recognised during pregnancy" refers to both gestational diabetes mellitus as well as diabetes mellitus throughout gestation (type 1 or type 2 diabetes diagnosed during pregnancy). The "other particular types" constitute a grouping of several dozen distinct causes. Diabetes is a far more complex diseases than previously thought, and individuals may have a variety of kinds.

#### **5.4.3 NUTRITIONAL MANAGEMENT OF DIABETES MELLITUS**

- **GENERAL CONSIDERATION:** Despite being caused by different pathophysiological processes, fasting and postprandial levels of glucose in plasma are connected. Due to postprandial hyperglycaemia, a patient's plasma glucose level at bedtime will determine how high their fasting hyperglycaemia will be the next morning. Similar to this, hyperglycaemia following a meal will be higher throughout the day if hyperglycaemia while fasting in the morning is higher. Therefore, if postprandial hyperglycaemia persists, strategies that solely target fasting hyperglycaemia may fail to normalise fasting plasma blood sugar levels and achieve adequate HbA1c levels. Conversely, if fasting hyperglycaemia continues, therapies

that solely target postprandial hyperglycaemia may not be successful in lowering HbA1c levels to acceptable ranges. However, one might clearly argue that for individuals with increased HbA1c levels but normal or close to normal fasting blood glucose levels.

- **Nonpharmacologic Interventions**

Simple lifestyle changes like exercise, weight loss, or dietary composition changes can be especially beneficial for people with IGT and type 2 diabetes who have suboptimal but manageable glycaemic control (HbA1c 7.0%–8.0%). For instance, numerous studies have shown that exercise and weight-reduction diets help normalise glucose tolerance in people with IGT and lower their chance of acquiring type 2 diabetes. Similar to this, consuming fewer high-glycaemic-index meals (such as those made with rice and potatoes instead of pasta) can reduce postprandial plasma glucose spikes and the median 24-hour plasma glucose concentration.

- **Pharmacologic Interventions**

Pharmacologic intervention is recommended if attempts at basic lifestyle adjustments have not resulted in an acceptable response. Only the recently introduced nonsulfonylureasecretagogues (which is the meglitinides, repaglinide, as well as nateglinide), the -glucosidase inhibitor (acarbose and miglitol), but rapid-acting diabetes medications particularly target postprandial hyperglycaemia of all diabetes medications available in the United States.

- **Meglitinides**

Meglitinides (repaglinide&nateglinide) constitute nonsulfonylurea insulin secretagogues which modulate early insulin release specifically. Both of these medicines bind to islet cells at different locations and with distinct kinetics than sulfonylureas. Although the end consequence is the same, namely the blockage of channelization of potassium that induces insulin production, these drugs only alter early insulin release. Because of this, as well as their short duration of action, they must be administered immediately before meals.

- **Repaglinide**

The first of the latest generation of nonsulfonylureasecretagogues, repaglinide, binds to the same transmitter as sulfonylureas as well as its own separate location on the cell. It has a quick and short-lived insulintropic activity after oral administration with meals. It has been demonstrated to be not less than as successful as glipizide and glyburide for the management of type 2 diabetic patients, as measured by HbA1c levels. This drug appears to cause less excess weight and hypoglycemia over most sulfonylureas. It can be used as a stand-alone treatment or in conjunction with metformin, a class of compounds and long-acting insulin.

- **Glucosidase Inhibitors**

Glucosidase inhibitors (acarbose&miglitol) slow carbohydrate digestion through selectively suppressing glucosidase enzymes in the small intestine brush border. Carbohydrate digestion and absorption are slowed, which decreases the subsequent increase in plasma glucose. Acarbose has also been demonstrated to stimulate glucagon-like peptide (GLP)-1 production, though the proportionate relevance of this impact to postprandial hyperglycemia reduction is uncertain. Acarbose and miglitol are both effective at lowering postprandial hyperglycemia. In general, this family of medications reduces HbA1c levels by roughly 0.5%. Due to flatulence, stomach pain, and diarrhoea, many patients are unable to tolerate these medications.

- **Insulin and Insulin Synthetics**

Postprandial hyperglycemia can be reduced by taking regular insulin or a combination of regular insulin with a longer-acting insulin before eating. Regular insulin, on the other hand, must be delivered between twenty and forty minutes before food consumption to have the best results. This is inconvenient, and patients rarely do it. Furthermore, normal insulin's 4- to 6-hour duration of action frequently leads in subsequent hyperinsulinemia and hypoglycemia before to the next meal. As a result, the emergence of synthetic insulin with a faster onset & shorter duration of effect has proved extremely beneficial to patients.

### **Insulin lispro**

The initial human hormone analogue licenced for diabetes treatment, is the result of a positional shift between its B28 the amino acid proline with B29 lysine. Insulin aspart is formed by the substitution of the amino acid aspartic acid with proline around position 28 on the insulin B chain. These changes inhibit hexamer formation and result in faster absorption, a faster beginning of action, increased initial plasma concentrations, and a shorter duration of action as compared to human regular insulin. Both insulins have very similar time-action profiles, with peak plasma levels typically occurring 40 to 50 minutes afterwards injecting (vs 60-90 minutes for normal insulin) and a duration of action ranging from 2 to 4 hours (vs 4-6 hours of action for regular insulin).

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## **5.5 Other Metabolic Disorder**

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Other than weight imbalance, cardiovascular disorder and Diabetes Mellitus, there are so many issues considered as metabolic disorder. Such as Familial hypercholesterolemia, Gaucher disease, Hunter syndrome, Krabbe disease, Maple syrup urine disease, Metachromatic leukodystrophy, Mitochondrial encephalopathy, lactic acidosis, stroke-like episodes (MELAS), Niemann-Pick, Phenylketonuria (PKU), Porphyria, Tay-Sachs disease, Wilson's disease. All of these are listed as inherited metabolic disorders.

The term "inherited metabolic disorders" refers to a variety of medical illnesses that are brought on by genetic flaws that interfere with the metabolism of the body and are typically inherited from both parents. These issues might also be referred to as inborn metabolic errors. Your body uses metabolism, a complicated series of chemical events, to produce energy and support life. In order for your body to store or immediately utilise food or specific chemicals as fuel, special enzymes must first break them down. Additionally, some chemical reactions convert compounds that your body lacks or breaks down those it no longer requires.

A metabolic problem happens when certain chemical processes don't function properly because of a hormone or enzyme shortage. Different types of inherited metabolic problems exist based on the particular chemical and whether it accumulates in dangerous proportions (because it cannot be broken down), is too low, or is absent. By performing routine screening tests at birth, some metabolic problems can be identified. Only after an infant or adult exhibits symptoms of a condition are others discovered. The kind and severity of an inherited metabolic condition will determine how it is treated. The range of recommended treatments for hereditary metabolic disorders, from limiting one's diet to liver transplants, can be rather wide.

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## **5.6 GI Tract Disorder**

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GIT disorders include things like GERD, diarrhoea, and colorectal cancer. Some disorders exhibit symptoms despite the GI system appearing to be healthy upon examination. There are apparent GI tract anomalies as well as symptoms for other disorders. The majority of digestive

illnesses are treatable or preventable.

GI disorders involve the entire gastrointestinal, or GI, tract, from the mouth to the stomach. There are two: structural and functional. Colitis, food-borne illness, lactose intolerance, and diarrhoea are a few examples.

Functional illnesses are those whereby the GI tract seems normal under the microscope but is dysfunctional in motion. These are the GI tract's (which includes your colon & rectum) most typical conditions. Examples include diarrhoea, bowel movements, and episodes of irritable bowel syndrome, feeling sick, gas, and bloating.

Your GI tract's motility, or capacity to keep moving, can be affected by a variety of variables, including:

- Consuming a fiber-poor diet.
- Not working out enough.
- Travelling or making other normal changes.
- Consuming a lot of dairy products.
- Stress.
- Putting off the impulse to go to the toilet, perhaps due to haemorrhoids.
- Overusing anti-diarrheal drugs that, over time, reduce the motility of the bowel motions.
- Taking aluminium or calcium-containing antacids.
- Using specific medications, including antidepressants, iron supplements, and potent analgesics like opioids.
- Pregnancy

Gastroenterologists are medical professionals who focus on gastrointestinal disorders. Proctologists are the medical professionals known as colorectal surgeons who specialise in gastrointestinal illnesses. The following are some of the conditions they frequently treat:

### **Constipation**

Constipation is a functional issue that makes it difficult for you to pass stools, or have regular bowel movements (a minimum of three times per week). Constipation is frequently brought on by insufficient "roughage" or fibre in your diet, a change in your regular schedule or diet, or both.

When you go to the toilet, you have to struggle because of constipation. Small, firm stools and occasionally anal issues like fissures or haemorrhoids might result from it. Rarely is constipation an indication of an additional serious medical issue.

At-home remedies for constipation include:

Adding more fibre and water into your diet will help. Regular exercise and gradually increasing your workout intensity. When you feel the urge, move your bowels because resisting it might lead to constipation. Laxatives can be helpful if these treatment options are unsuccessful. Always abide by the directions on your laxative's label and your doctor's recommendations.

### **IBS, or irritable bowel syndrome**

A functional disorder known as irritable bowel syndrome, which (also known as spastic colon, irritated colon, IBS, and nervous stomach) causes your intestinal muscles to contract more or less

frequently than "normal." IBS may be brought on by certain meals, medications, and emotional stress, among other things.

IBS symptoms include:

- Cramping and soreness in the abdomen.
- Extra gas.
- Bloating.
- Changes in bowel patterns, such as unusually hard, loose, or urgent faeces.
- Both diarrhoea and constipation.

IBS can be managed at home by:

- Limiting your caffeine intake.
- Adding more fibre to your diet.
- Keeping track of the foods that make your ibs flare up (and avoiding them).
- Reducing stress or discovering new coping mechanisms.
- Taking prescription medications as directed by your doctor.
- Preventing dehydration and maintaining adequate fluids all day.
- Getting a good night's sleep.

## **Hemorrhoids**

Your anal canal has dilated veins, which are haemorrhoids. It is a structural condition. They are brought on by long-term excess pressure from bowel movement straining, persistent diarrhoea, or pregnancy. Haemorrhoids come in internal and exterior varieties.

Blood vessels inside your anal entrance are internal haemorrhoids. They get inflamed and begin to bleed when they strain and drop into the anus. Internal haemorrhoids may eventually descend to the point where they haemorrhage (sink or stick) outward of the anus

Treatment consists of:

Improving your bowel behaviours (such as not struggling during bowel motions, moving your stool when you feel the urge, and avoiding constipation).

The vessels are removed by your healthcare provider utilising ligating bands. Your healthcare provider performs a surgical removal. Only a small percentage of persons with really large, painful, and chronic haemorrhoids require surgery.

Veins that are barely under cutaneous layer on the outermost layer of the anus are known as external haemorrhoids. The outside hemorrhoidal veins might rupture as a result of tension, and a blood clot can develop beneath the skin. The term "pile" refers to this excruciating condition. Under local anaesthesia, the clot associated vein can be removed, as well as the haemorrhoid itself.

## **Alveolar fissures**

Another structural condition is anal fissures. They are breaks or cracks in your anus' lining. The passage of extremely hard or wet faeces is the most frequent reason behind an anal fissure. The underpinning muscles that regulate the movement of faeces through the urinary tract and vacated of the body are exposed by the gap in the anal lining. One of the most agonising conditions you can

have is an anal fissure because these exposed muscles can become inflamed from exposure to air or excrement. After bowel movements, this causes excruciating burning discomfort, blood loss, or spasms.

Painkillers, dietary fibre to prevent the incidence of large, bulky stools, and sitz baths (taking a seat in a few inches of warm water) are all part of the first course of treatment for anal fissures.

### **A perioral abscess**

Perianal pustules, also a structural illnesses, can take place when the tiny analgesic glands which open on the inner surface of your anus grows into blocked, as well as the bacteria constant presence in these tiny glands causes an inflammation. An abscess arises when pus forms. The abscess is normally drained at the doctor's office while the patient is under local anaesthesia.

### **Alveolar fistula**

Following drainage of an abscess, an anal fistula—once more, a structural disease—often develops. It's a strange, tube-like channel that connects your anus opening to a hole inside the skin in the anal canal. Itching and irritation are brought on by bodily wastes that are channelled into your anal canal and discharged through the skin. A fistula can also bleed, hurt, and drain.

### **Diverticular condition**

Diverticulosis is the development of small protrusions (diverticula) in your large intestine's muscular wall that happen to form in weak spots in the gut. The sigmoid colon, a high-pressure region of the bottom large intestine, is where they typically develop. Diverticular illness is particularly prevalent in Western societies, where it affects 10% of adults over 40 over 50% of those over 60. Too little roughage (fibre) in the diet is a common contributor to it. Diverticulitis can occasionally progress from diverticulosis.

10% of individuals with outpouchings develop complications from diverticular illness. They include diverticulitis, an infection or inflammation of the pouches that can cause bleeding and blockage. Constipation must be treated as part of diverticulitis treatment, and if it is extremely severe, antibiotics may also be prescribed. In cases of severe difficulties, surgery is required to remove the affected, diseased portion of the colon.

### **Both cancer and colon polyps**

The second most frequent type of cancer in the US, colorectal cancer, is diagnosed in 130,000 Americans every year. Fortunately, bladder cancer represents one of the most effectively treatable types of the disease thanks to improvements in early identification and treatment. It is feasible to prevent, detect, and cure the condition long before symptoms show up by employing a range of screening tests.

### **Colitis**

There are various forms of colitis, which is which are illnesses that result in intestinal inflammation. These consist of:

- Colitis caused by an infection.
- Colitis with ulcers (unknown origin).
- Crohn's disease (unknown cause).
- Ischemic colitis (due to insufficient blood supply to the colon).
- Colitis caused by radiation therapy.

Diarrhoea, rectal bleeding, abdominal cramps, and urgency (a frequent, urgent need to empty the bowels) are all symptoms of colitis. The diagnosis, typically is made through colonoscopy and biopsy, determines the course of treatment.

### **5.6.1 PATHOPHYSIOLOGY OF GI TRACT DISORDER**

Functional symptoms are largely caused by motor, vascular, or secretory changes that are peripherally mediated by autonomic, and perhaps humoral, agents and centrally connected to corticohypothalamic impact.

The motor abnormalities result in a wide range of dysrhythmias or dyskinesia's, which ultimately manifest as symptoms including discomfort, fullness, nausea, vomiting, pyrosis, and diarrhoea. The identical set of symptoms are frequently caused by secondary irritation-induced dyskinesia's that are produced by organic lesions. This explains why the majority of gastrointestinal symptoms are non-specific. Human subjects' vascular alterations, which are unmistakably correlated with emotion, have been thoroughly reported; the classic example is the guy named Tom, who was spotted by Wolf and Wolf. Through stomach fistulas, physiological observations were made in this instance. They noticed that Tom's gastrointestinal mucosa grew pallid whenever he displayed withdrawal symptoms (such as fear, depression, resignation, or sadness). Decreased mobility and secretion occurred along with this. Tom's mucosa engorged and increased motility and secretion, however, when he felt more hostile or hostile feelings (anxiety, hostility, resentment). Additionally, they pointed out that oligemic mucosa was very susceptible to chemical or mechanical harm.

The function of submucosal arteriovenous shunts determines the differences in the mucosa's vascularity. Pharmaceuticals, chemicals, and other substances can also have an impact on these shunts.

### **5.6.2 CLINICAL SIGNIFICANCE OF GI TRACT DISORDERS**

The study of healthy digestive system processes and digestive system diseases is known as gastrointestinal science. It is also known as gut health science at times. Taking proper care of gastrointestinal tract is crucial since it has a direct impact on your overall health and wellbeing. haemorrhaging bloating, constipation, diarrhoea, dysphagia (indigestion), flatulence (gas), indigestion, discomfort, nausea, and vomiting are a few typical signs of poor digestive health.

#### **Disorders of the digestive system**

GIT disorders come in two flavours: structural and functional. Let's examine each in greater depth and comprehend the key distinctions between the two.

#### **GI functional disorders**

Functional disorders are those where the gastrointestinal tract seems healthy but does not function properly. The colon and the rectum are among the most typical gastrointestinal problems. Constipation, IBS, nausea, gastrointestinal gas, bloating, GERD, and diarrhoea are a few typical instances.

#### **GI structural disorders**

When you have a structural disorder, your bowel behaves abnormally and does not seem normal. Examples of common conditions include colon polyps, inflammatory bowel disease, diverticular disease, strictures, stenosis, haemorrhoids, and diverticular disease.

The following is a discussion of several significant digestive tract disorders and conditions:

#### **Blood loss from the digestive tract**

The disease known as gastrointestinal bleeding causes blood to show up in stool or vomit. Even

though the bleeding is not always apparent, it causes black or tarry stools. It may be fatal to have excessive bleeding. If you notice blood in the stool, especially if it has turned maroon or black, we advise you to consult a doctor very once. 1-2 forms of gastrointestinal bleeding are possible.

- **Reddish blood**

Occurs as a result of haemorrhaging in the lower colon. Usually, it manifests as piles or fissures. It may occasionally be a result of cancer or a polyp in another bodily part.

- **Brown or maroon in colour**

Blood that is maroon comes out with the stool. Hematochezia is the name given to this condition. Typically, anomalies in the longitudinal or ascending colon cause it to occur.

- **Dark black**

This disorder, also known as melena, is brought on by an ulcer in the upper gastrointestinal tract (GI).

### **Cancer of the digestive system**

Gastrointestinal cancer is the term used to describe any form of cancer that appears along the GI tract. It can happen in the liver, rectum, the anus, gall bladder, small and large intestines, pancreas, colon, and biliary system. GI cancer is more deadly because its early stages are characterised by the absence of symptoms. These signs may be seen in people with GI cancer in its latter stages:

- Abdominal cramping or discomfort
- Bloody, sluggish stool
- Diarrhoea, bowel movements, and dyspepsia on a regular basis
- Stool narrowing or changing consistency
- Swallowing and digestion issues
- Jaundice (eyes and skin that seem yellow)
- Nausea and diarrhoea
- Stomach bloating
- Fatigue, fragility, weight loss, or appetite loss

### **Hepatic cirrhosis**

The damage to the liver is the most harmful effect of the modern lifestyle, diseases, alcohol, and viruses on our bodies. All of these things initially create fatty liver, or liver inflammation. As the injury worsens, the liver becomes more rigid and inflamed, which creates irreversible scarring that causes the liver to shrink, a condition known as liver cirrhosis.

### **Inflammatory Bowel Syndrome**

It is a gastrointestinal condition that results in discomfort, diarrhoea, and constipation. Gastrointestinal contractions, infections in the stomach from specific meals, or modifications in intestinal bacteria are the causes of irritable bowel syndrome.

It typically affects adolescents and young children. However, individuals with mental health

conditions like sadness and anxiety are also susceptible to this problem.

If a patient experiences a consistent change in bowel habits, ongoing discomfort in their stomach, or unexplained weight loss, they should consult a doctor right away.

### **Hiatal Hernia**

When the muscle known as the diaphragm, which shields your chest from your abdomen, allows a portion of your gastrointestinal tract to stick out into it, a hiatal hernia results. If you see any bulges in the abdomen or anywhere else, you should see a doctor right away.

### **Haemorrhoids**

Haemorrhoids, also referred to as piles, are enlarged veins that mimic veins with varicose veins in the region between the rectum and anus. Haemorrhoids come in two varieties: internal haemorrhoids, which form inside the rectum, and external haemorrhoids, which form beneath the skin around the anus. Haemorrhoids can cause itchiness or irritation at the anus, pain or discomfort when sitting, bleeding, swelling, or hard lumps.

If a patient experiences blood during stool production or haemorrhaging that don't go away after seven days of at-home care, they should see a doctor. It could indicate a sign of a tumour in some situations.

### **5.6.3 NUTRITIONAL MANAGEMENT OF GI TRACT DISORDER**

In addition to supplying the nutrients required for energy and bodily growth and repair, diet also influences and controls a number of critical bodily processes. The amounts and types of gastrointestinal hormone released into the circulatory system are influenced by the ratios of proteins, carbs, and fats in our diet. These hormones control hunger, cell growth, gastrointestinal motility, emission and absorption, and local immunological defences. Additionally, in the so-called gut-brain axis, the enteric, autonomic, as well as peripheral neurological systems communicate and work together with the gastrointestinal hormone peptides and amines. The gut microbiota, which is thought to play a significant role in both health and disease, is impacted by food intake as well.

This topic is dominated by the function of nutrition in the pathophysiology of treating irritable bowel syndrome (IBS). This is true not only because Nutrients recently published a special issue on diet and inflammation in the intestines, but also because diet is crucial to the pathogenesis and treatment of IBS. Seven original pieces, two communications, and one review are included in this issue. The published data are fresh, intriguing, and very relevant to clinical practice.

Significance of Diet for the Treatment of IBS Asia has a lesser prevalence of IBS than the west, and it presents differently clinically. It also likely has a distinct aetiology. Asian cuisine is known for its complex recipes, which frequently use foods high in FODMAPs (fermentable sugars, disaccharides, monosaccharides, and polyols). Due to this circumstance, it is difficult to assess how a low-FODMAP diet may affect Asian IBS patients. In this article, the impact of a low-FODMAP eating plan on Thai patients with IBS is contrasted with that of the diet that is most frequently advised, which is a form of the NICE-modified diet. A low-FODMAP diet was found to be effective in 60% of Thai IBS patients, which is comparable to claims that 50% to 72% of IBS patients in the west do the same.

IBS sufferers' low density of underlying enter endocrine cells is thought to be a key factor in the underlying cause of the condition. Both the sparse number of stem cells in the intestinal tract and the slow pace of differentiation of stem cells into enter endocrine cells appear to be contributing factors to the low density of enter endocrine cells. In one of the articles within this issue, it is hypothesised that by-products of bacterial diet fermentation interact with gut stem cells, resulting in a low

differentiating rate into hormone-producing cells, which manifests as digestive problems. Dysmotility, abdominal hypersensitivity, and unusual gastrointestinal secretion. The symptoms of IBS would then develop as a result of this. One of the more invasive surgical treatments used on patients with cancer of the digestive tract is oesophagectomy. This issue addresses the post-operative nourishment of patients who experienced oesophagectomy. In contrast to enteral nutrition (EN) and intravenous nutrition (PN), this study demonstrated that post-operative oral feeding (PO) improves post-operative nutritional status as well as overall prognosis. Similar information on the outcomes of surgical procedures for colorectal cancer in experimental animals was also reported by those authors. The findings of the research are extremely practically applicable and ought to be taken into consideration while treating the diet of gastrointestinal cancer patients.

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## **5.7 Liver & Gallbladder Disorder**

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Any disorder that compromises the function of your gallbladder is referred to as gallbladder disease. A tiny organ in the gut called the gallbladder. Your small intestine receives some of the digestive bile your liver produces and stores it there to aid in the digestion of food. The bile ducts, a network of pipes, are used to do this.

Your gallbladder or the bile ducts that link to it may develop gallbladder disease first. Your gallbladder may become backed up if these ducts become infected or blocked. Gallbladder disease can also affect other digestive system organs because the bile ducts link your gallbladder to them.

Gallbladder illnesses include:

### **Cholelithiasis (gallstones)**

Although gemstones are the most frequent cause of gallbladder issues, they are not always problematic. Gallstones form when extra bile products, mostly cholesterol, build up in your gallbladder and form lumps that allow themselves to grow and amass. Gallstones can exist and go unnoticed if there are no symptoms. However, if they obstruct the bile ducts or gallbladder, they may become problematic.

### **Inflammation of the bile ducts**

The most prevalent sign of gallbladder illness, cholecystitis, can also be problematic on its own. Cholecystitis (inflammation) may indicate a gallbladder infection or obstruction, a structural obstruction, or, less frequently, malignancy. Gallstones that obstruct bile flow are the main culprit. Chronic inflammation can result in gangrene, perforation, and even scarring from the gallbladder tissue.

### **Gangrene**

One of the more dangerous side effects of chronic cholecystitis is gallbladder gangrene. Chronic inflammation that causes the gallbladder to continue to enlarge and distend over time might finally cause tissue death. The risk of rupture or ripping exists in dead tissues. A perforation in the membrane of the gallbladder can increase the risk of getting an infection (peritonitis) in the remaining portion of the abdominal wall. This serves as another reason cholecystitis must be taken carefully.

### **Biliary dyskinesia**

Also known as functional gallbladder condition, is a motility issue. This indicates that there is an issue with your gallbladder's capacity to discharge bile into the bile ducts. The effects of a functional motility issue are the same as those of a gallstone or a different blockage in your bile ducts or gallbladder. It results in bile buildup in your gallbladder, which causes persistent inflammation.

However, in this instance, the issue is mechanical and involves the muscles or nerves.

### **Bladder cancer**

It is uncommon but serious to develop gallbladder or cancer of the bile ducts. Healthcare professionals handle any potential danger of gallbladder cancer pro-actively because signs of gallbladder cancer frequently don't show up until the later stages. The majority of gallbladder polyps are benign tumours or growths. However, if your polyp is larger than typical, your doctor could advise having it removed just to be safe.

### **Cholangiopathy**

Any bile duct disease is a cholangiopathy. Cholangitis, which can be brought on by an acute infection, a blockage, or a chronic autoimmune condition like primary biliary cholangitis, is the traditional first sign of cholangiopathy. The bile ducts may scar and narrow as a result of chronic cholangitis (biliary stricture). This may result in bile.

Reviewing some of the greatest prevalent conditions that might affect the liver and those associated with the gallbladder:

- A liver problem
- Hepatitis
- Cirrhosis
- Liver cellular cancer
- Steatohepatitis without alcohol
- Liver encephalopathy
- Wilson's illness
- The syndrome of Gilbert
- Cholestasis
- Cholecystitis and gallstones
- Cholangitis

Bile is a viscous, sticky, greenish-yellow fluid that is produced by the liver. By making cholesterol, lipids, and vitamin D that is fat-soluble easier for absorption from the colon, bile facilitates digestion. Additionally, bile aids in the body's removal of some waste materials, primarily excess cholesterol and bilirubin.

The tiny tubes (ducts) that connect the liver through the gallbladder and ultimately to the smaller intestine make up the biliary tract. Under the liver, in a tiny pear-shaped sac, is the gallbladder. It holds the bile. When bile is required, such as when humans consumption, the gallbladder contracts, forcing bile into the small intestine through the bile ducts.

Bile can be prevented from flowing by the following:

- Gallstones that exit the gallbladder and travel into the ducts
- During gallbladder surgery, the bile ducts may become damaged.
- Bile duct narrowing brought on by conditions like AIDS-related infections including primary sclerosing cholangitis

- Pancreatic conditions that might cause the bile ducts to become more constrained as they journey through the pancreas.
- Pancreatic, the gall bladder, or bile canal tumours
- The presence of parasites
- The gallbladder could grow inflamed (cholecystitis) if the bile ducts are clogged.

### **5.7.1 PATHOPHYSIOLOGY OF LIVER AND GALLBLADDER DISORDER**

Cholecystitis and gallstones are the disorders common causing by liver & gallbladder disorder. Inflammatory gallbladder, or cholecystitis, typically results from a stone in the gallbladder obstructing the cystic duct.

- People typically experience nausea, fever, and abdominal pain.
- Gallbladder inflammation may typically be detected using ultrasound technology.
- A laparoscope is frequently used to remove the gallbladder.

Under the liver, in a tiny pear-shaped sac, is the gallbladder. Bile, a substance the liver produces and which aids in digestion, is kept there. When bile is required, such as when humans eat, the liver's gallbladder contracts, forcing bile into the intestinal tract through the bile ducts. The most typical issue brought on by gallbladder stones is cholecystitis. When a stone obstructs the cystic duct, which transports bile from the gallbladder, the condition arises.

Acute or chronic cholecystitis are the two categories.

#### **Acute cholecystitis**

Acute cholecystitis is characterised by a sudden onset of severe, ongoing abdominal pain. Gallstones are present in at least 95% of patients with acute cholecystitis. Infection may come later, but inflammation almost usually starts without it. The gallbladder's walls may thicken and swell with fluid as a result of inflammation.

Acalculous cholecystitis is a rare kind of acute cholecystitis that doesn't involve gallstones. Sludge, however—microscopic fragments of substances comparable to those in gallstones—might be present in the gallbladder. The severity of acalculous cholecystitis is greater than that of other varieties. It frequently happens following:

- Major operation
- Serious wounds, severe burns, or an infection of the bloodstream (sepsis) are examples of critical illnesses.
- Long-term intravenous feedings
- Observing a protracted fast
- Immune system weakness conditions characterised by inflammation of the blood vessels (vasculitis), which include systemic lupus erythematosus as well as polyarteritis nodosa.

#### **Persistent cholecystitis**

Inflammation of the gall bladder that has persisted for a long time is known as chronic cholecystitis. It nearly always follows episodes of acute cholecystitis and gallstones. Biliary colic, which is characterised by recurrent pain bouts (chronic cholecystitis), is brought on by gallstones that intermittently obstruct the cystic duct.

The gallbladder may develop thick-walled, scarred, and tiny tissue as a result of repeated outbreaks of acute inflammation, which are typically brought on by gallstones, in chronic cholecystitis. The cystic tube itself may be blocked by the gallstones as well as the gallbladder's entry to it. Sludge is typically also present in the gallbladder. If the scarring is severe, calcium could be deposited in the gallbladder's walls, hardening them (producing a porcelain gallbladder).

Gallstones are clumps of solid matter (often cholesterol crystals) in the gallbladder.

- The gallbladder is where extra cholesterol that has been secreted by the liver and transported with bile forms solid lumps and builds up.
- Upper abdominal pain brought on by gallstones can occasionally continue for hours.
- Gallstones can be found with reasonable accuracy using ultrasonography.
- The gallbladder gets removed when gallstones result in persistent pain or other issues.

Under the liver, in a tiny pear-shaped sac, is the gallbladder. Bile, a substance the liver produces and which aids in digestion, is kept there. When bile is required, such as when humans eat, the gallbladder agreements, forcing bile into the small intestinal tract through the bile ducts.

Gallstones could hurt. When gallbladder stones enter the cystic duct, normal bile duct, as well as ampulla of Vater along with clog the duct, pain is caused. When the gallbladder swells, biliary colic, a type of discomfort, develops. The right side beneath the ribs is typically where the pain is located in the upper abdomen. Particularly for elderly individuals and those with diabetes, it might be challenging to locate the exact place at times. The discomfort usually gets worse over 15 to 60 minutes and stays constant for a maximum of twelve hours. Usually, the pain is terrible enough to require a trip to the emergency room. When the pain starts to go away, it does progressively over the course of thirty to eighty minutes and leaves a dull soreness. Many people experience nausea.

### 5.7.3 NUTRITIONAL MANAGEMENT OF LIVER & GALLBLADDER DISORDER

It is obvious that malnutrition predominates in liver illnesses and that it can be caused by a variety of things, including decreased food intake, impaired digestion, and malabsorption, a rise in energy requirements, ineffective protein synthesis, a quickening of protein deterioration, and a rise in protein oxidation. The patient's diet needs to be customised.

For a patient with liver illness, maintaining enough nutrition, preventing the breakdown of the body's protein tissue, controlling oedema especially ascites, and preventing encephalopathy symptoms should be the main objectives of nutritional therapy.

However, because each illness condition is unique, so too are the nutritional suggestions. We'll examine the dietary suggestions for each illness condition in turn.

#### Dietary guidelines for liver patients

| Nutrients           | Hepatitis                           | Cirrhosis                     | Encephalopathy                                                         |
|---------------------|-------------------------------------|-------------------------------|------------------------------------------------------------------------|
| Kilocalories (Kcal) | 25-30 kcal/kg                       | 30-35 kcal/kg                 | 25-30 kcal/kg                                                          |
| Carbohydrates (g)   | 300-400                             | 300-400                       | 450                                                                    |
| Protein (g)         | High 1.5-2 g/ kg<br>(100 g or more) | Moderate 0.8-<br>1g/kg (70 g) | Grade I-II 1g/kg<br>BW Grade III-IV<br>0.6 to 0.8g/kg/BW<br>(for short |

|                        |                                                                   |                                                  |                                                     |
|------------------------|-------------------------------------------------------------------|--------------------------------------------------|-----------------------------------------------------|
|                        |                                                                   |                                                  | duration)                                           |
| Fat (g)*               | Moderate 30%<br>total Kcal                                        | total Kcals Low<br>25%                           | slowly increase to<br>25-30%                        |
| Vitamins &<br>minerals | Vitamin B and C,<br>Folic acid, calcium,<br>magnesium and<br>zinc | B group and C, Fe<br>if anaemia Ca, Mg<br>and Zn | Vitamin B and C,<br>Fe if anaemia, Ca,<br>Mg and Zn |

Someone with liver cirrhosis is advised to consume a diet high in carbohydrates, moderate in protein, and low in fat. Vitamin and mineral supplements are often recommended. Delivered that anorexic is at its worst, the food ought to be delivered in small, frequent meals (6 to 8 meals). Depending on the phase of acute illness and recuperation, the diet must proceed from a liquid, soft diet to a typical food. It is necessary to use spices and condiments carefully to pique appetite. In between meals, high-calorie, high-protein beverages are helpful. In the event of encephalopathy issues, protein should be adjusted as necessary. Additionally, fat must be reduced and then raised gradually as the individual advances. The nutritional status should be improved or maintained through nutrition treatment. Depending on the patient's level of tolerance and the severity of their malnutrition, customised meals must be administered. It is beneficial to give the patient dietary and food advice.

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## 5.8 Pancreatic Disorder

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A gland called the pancreas is located in front of your vertebral column and behind your stomach. It creates hormones that assist control the level of sugar in the blood and juices that aid in the digestion of food. Numerous health issues can result from pancreatic issues. These consist of:

Pancreatic inflammation, often known as pancreatitis:

- When digestive enzymes begin breaking down the pancreas itself, this occurs.
- Cancer of the pancreas
- A genetic disease called cystic fibrosis causes thick, sticky mucus, which can obstruct pancreatic ducts.

Diabetes also involves the pancreas. When a person has type 1 diabetes, their pancreatic beta cells stop producing insulin as a result of an immune system attack. The pancreas ceases to produce enough insulin in answer to meals when a person has type 2 diabetes.

The pancreas, or digestive tract, is a six-inch long, oblong, flattened gland that is situated deep within the belly, between the spine and the stomach. The tail, body, neck region, head, and uncinated region are its five primary components.

An essential component of the gastrointestinal system is the pancreas. It produces fluid from the stomach and enzymes that the duodenum releases to aid in the breakdown of proteins, carbs, and lipids. The exocrine portion of the pancreas is referred to as this.

### Acute pancreatitis

The painful and occasionally fatal illness known as chronic pancreatitis is an inflammation of the pancreas. The most frequent reason for acute pancreatitis is gallbladder stones. The fatality rate of severe pancreatitis has maintained at roughly 10% over the past twenty decades, despite significant advancements in critical care treatment.

## **Autoimmune Pancreatitis (AIP)**

A persistent inflammatory condition known as autoimmune pancreatitis (AIP) that responds to steroid medication is thought to be brought on by the immune system of the person attacking the pancreas. Type 1 & type 2 AIP subtypes are now recognised.

## **Chronic Pancreatitis**

A pancreatic inflammation known as chronic pancreatitis worsens over time and results in lasting damage since it does not cure or get better. A patient's capacity to breakdown food and produce pancreatic hormones is eventually compromised by chronic pancreatitis. The disease typically strikes people between the ages of 30 and 40 and is more prevalent among men. Because the symptoms share characteristics at first, chronic pancreatitis could be mistaken for acute pancreatitis.

## **Diabetes**

Diabetes affects the way your organism uses food for strength and growth, or metabolism. It specifically has to do with how poorly the body uses glucose. Diabetes is a disease in which the body's insulin and blood sugar levels are out of whack. By 2050, it's predicted approximately one in four Americans will suffer from diabetes, making it one of the greatest prevalent diseases in the country.

## **Hereditary Pancreatitis**

Recurrent episodes of pancreatic inflammation that frequently develop into chronic pancreatitis in adolescence characterise the genetic illness known as hereditary pancreatitis. Patients with familial pancreatitis typically begin to exhibit acute pancreatitis symptoms in childhood, in contrast to the majority of other types of pancreatitis.

## **Familial pancreatitis**

The term "familial pancreatitis" refers to families where the incidence of pancreatitis is higher than would be predicted by chance. It takes at least two first- or second-degree relatives who have idiopathic pancreatitis that has not been linked to obstructing or environmental variables for a determination of familial pancreatitis to be made.

## **Familial Chylomicronemia Syndrome (FCS)**

A uncommon genetic condition of fat metabolism known as familial chylomicronemia syndromes (FCS) is characterised by abnormally high peripheral triglyceride levels that are 10 to 100 times or more above normal. One in one million to two million persons are thought to have FCS. Gender, colour, and ethnicity are all equally impacted by FCS, which can be identified at any age.

## **Pancreatic cancer**

When it comes to cancer-related deaths, pancreatic cancer ranks fourth among men and fifth among women. In the US, it accounts for in excess of 37,000 new cases each year. Many common therapies, such as chemotherapy and radiation therapy, are ineffective in treating pancreatic cancer. This cancer develops slowly and at first shows no symptoms.

## **Pediatric pancreatitis**

Children who have paediatric pancreatitis experience pancreatic inflammation. Paediatric pancreatitis comes in two flavours: acute and chronic. Paediatric acute pancreatitis, once thought to be a rare condition in children, has become more common over the last ten to twenty years and now affects roughly 1 in 10,000 kids.

### **5.8.1 PATHOPHYSIOLOGY OF PANCREATIC DISORDER**

Loss of intracellular plus extracellular compartmentation, disruption of pancreatic secretory transport, and activation of pancreatic enzymes are the hallmarks of acute pancreatitis' pathogenesis. In biliary pancreatitis that is severe, the breakdown of pancreatic ductules and consequent decline in extracellular compartmentation are caused by outflow blockage caused by pancreatic duct hypotension and bile salt toxicity. Alcohol causes functional changes in plasma membranes and changes the ratio of protease inhibitors to proteolytic enzymes, which leads to the activation of enzymes, autodigestion, and cell death. Interstitial edoema and infiltration of inflammatory agents are the primary symptoms of acute pancreatitis once the condition has begun.

### **5.8.2 CLINICAL SIGNIFICANCE OF PANCREATIC DISORDER**

The doctor will likely press on your abdomen to determine whether it is sore and examine your blood pressure, fever, and pulse rate to discover if you have acute pancreatitis.

X-rays or imaging exams like a CT scan or MRI can reveal whether the pancreas appears calcified and help diagnose chronic pancreatitis. Your physician will examine your stool for extra fat, an indication that the digestive tract is discontinued producing enough enzymes to breakdown fat, and take blood tests. To determine how effectively the pancreas generates digestive enzymes, you could undergo a pancreatic function test. Diabetes may also be examined in you.

Two digestive enzymes, amylase and lipase, are measured in your blood to help your doctor determine if you have acute pancreatitis. You most likely have acute pancreatitis if you have excessive amounts of these two enzymes. The white cells in your blood, blood sugar, calcium, & liver function in your blood will also be examined.

Other examinations might be:

- To determine whether your stomach's pancreas is producing the proper number of digestive enzymes, you can do a pancreatic function test.
- The pancreas is imaged using ultrasound, CT scanning, and MRI to determine the degree of inflammation, the presence of complications such cysts, and the reasons, such as bile duct issues and gallstones.
- ERCP, during which your doctor examines your pancreas and bile ducts using a long tube containing a camera at the end
- During a biopsy, your doctor takes a small sample of tissue from the pancreas to be examined with the help of a needle.

Your doctor might do blood and stool tests in some circumstances in order to confirm that the diagnosis is correct. A hypoglycaemia tolerance test may also be performed to assess the degree of cell damage.

### **5.8.3 NUTRITIONAL MANAGEMENT OF PANCREATIC DISORDER**

An essential component of pancreatitis sufferers' treatment is nutrition. The following are the main objectives of nutritional therapy for chronic pancreatitis:

- Prevent dietary deficits and malnutrition
- Keep blood sugar levels balanced (avoid both hypo- and hyperglycaemia)
- Diabetes, renal issues, and other illnesses linked to chronic pancreatitis should be avoided or managed as best as possible.

- Preventing an acute pancreatitis episode

Pancreatitis patients should consume high-protein, nutrient-dense diets consisting of vegetables, whole grains, low-fat dairy products, and other sources of lean protein in order to best meet these objectives. In order to assist prevent malnutrition and suffering, it's vital to abstain from alcohol and fried or greasy foods.

Every patient's situation is different and necessitates a specific strategy, thus nutritional evaluations and dietary changes are conducted on a case-by-case basis.

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## **5.9 Renal Disorder**

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Each of your two kidneys is roughly the size half your fist. They are located right below the rib cage, in the centre of your back. Nephrons, which are a million or more small structures, are found inside each kidney. They clean the blood. They eliminate wastes and surplus water, which turns into urine. Urine travels through tubes known as ureters. Your bladder receives it and retains the urine till you use the loo.

Nephrons are typically the target of kidney illnesses. Kidney impairment could make it difficult for them to eliminate waste. Genetic issues, trauma, or medications are examples of potential causes. If you have type 2 diabetes, a high blood pressure level, or a close relative who has renal disease, your chance of developing kidney disease is increased. The nephrons are gradually damaged by chronic kidney disease.

### **5.9.1 PATHOPHYSIOLOGY OF RENAL DISORDER**

Doctors frequently focus more on the true cause of the problem when treating renal disease. If bacteria are the cause of the infection, antibiotics can also treat it. This plan functions best when renal failure is sudden and severe. In such circumstances, treating the underlying reason can aid in getting the kidney back to normal operation. However, in the majority of kidney failure instances, blood pressure must first be returned to its normal level in order to prevent the disease from worsening.

Dialysis or kidney transplants are the sole treatments for end-stage renal failure. Depending on the situation, dialysis may be performed once or twice a week. In the event of a transplant, fresh, healthy kidneys replace the damaged ones.

### **5.9.2 CLINICAL SIGNIFICANCE OF RENAL DISORDER**

Conditions that harm your kidneys and lessen their capacity to maintain you healthy by eliminating waste from your blood are included in chronic kidney disease. Wastes can accumulate to high amounts in the bloodstream and make you appear ill if renal disease progresses. You could have issues like:

- Low blood count anaemia (high blood pressure)
- Brittle bones, inadequate nutrition, and nerve damage

Your chance of developing diseases of the heart and arteries is also increased by kidney disease. These issues may develop gradually over a lengthy period of time. Often, chronic kidney disease can be prevented from getting worse by early detection and treatment. As kidney disease worsens, renal failure may develop, which calls for dialysis or transplantation of the kidneys to stay alive.

### **5.9.3 NUTRITIONAL MANAGEMENT OF RENAL DISORDER**

An assortment of lipids, carbs, and proteins make up a balanced diet. To maintain healthy levels of sugar and salt, stay away from processed foods and carbonated beverages. To prevent their children from becoming overweight, parents should keep them active, healthy eaters, and fit. To keep their

kids fit, parents should encourage their kids to participate in athletics and other physical endeavours.

Chronic renal disease can strike anyone at any age. However, kidney disease might occur in certain persons at a higher rate than others. Kidney illness may be more likely to affect you if you:

- have high levels of blood pressure with diabetes
- have a history of renal failure in your family
- Are older and are members of a demographic with a high prevalence of diabetes or hypertension, such as American Indians, Asians, and Pacific Islanders.

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## **5.10 Stress & Trauma Causing Cancer**

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Post-traumatic stress disorder symptoms can appear in cancer patients at any stage of the disease, including during diagnosis, treatment, the end of treatment, and recurrence. Both adult cancer survivors as well as their loved ones may experience post-traumatic stress disorder.

PTSD, also called post-traumatic stress disorder, may or may not develop as a result of cancer-related PTS. A unique set of symptoms known as PTSD affects those who have survived traumatic experiences. The potential of death or severe injury to someone else or oneself is typical in these situations. Distress may result from cancer and its treatment, but PTSD does not necessarily follow. Throughout your battle with cancer, your medical team will assess your symptoms.

When particular triggers are connected with a distressing occurrence, conditioning happens. Even when they happen alone, before the trauma has passed, neutral stimuli (such as scents, sounds, anxiety sights) that happened concurrently with distressing triggers (such instance chemotherapy or uncomfortable treatments) subsequently create anxiety, stress, and terror.

In individuals with PTSD from a prior traumatic event, specific triggers during cancer treatment (such being in MRI and CT scanners) may cause symptoms to recur. These people could similarly struggle to cope with their cancer and its treatment.

### **5.10.1 PATHOPHYSIOLOGY OF STRESS & TRAUMA CAUSING CANCER**

Cancer patients will be helped to maintain an appropriate weight for their age, retain their strength, and lessen side effects both before and after treatment by eating primarily plant-based meals and engaging in regular exercise.

When tumours affect the head, neck, oesophagus, stomach, intestinal tract, pancreas, or liver, nutrition issues are likely to occur.

The side effects of cancer therapies make it challenging for many people to eat healthfully. The following cancer therapies have an impact on nutrition:

- Chemotherapy.
- Hormone treatment.
- Radiation treatment.
- Surgery.
- Immunotherapy.
- Transplant of stem cells.

Taste, odour, appetite, and the capacity to consume enough food or assimilate nutrients from food can all be impacted by cancer and cancer therapies. Malnutrition, a disorder brought on by a lack of

essential nutrients, may result from this. Malnutrition may be more likely in people who abuse alcohol and are obese.

#### **5.10.2 CLINICAL SIGNIFICANCE OF STRESS & TRAUMA CAUSING CANCER**

A patient who is malnourished may become weak, exhausted, and unable to fend off an infection or complete cancer therapy. Malnutrition can therefore worsen the patient's state of life and perhaps endanger their life. The progression or spread of the cancer may exacerbate malnutrition. Protein and calories must be consumed in the proper proportions to promote healing, fight illness, and provide adequate energy.

Loss underlying appetite and desire to eat is a symptom of anorexia. It is a typical symptom among cancer patients. If the cancer develops or spreads, anorexia may develop early in the illness or later. When given a cancer diagnosis, some people already struggle with anorexia. Anorexia affects the majority of cancer patients with advanced disease. The most frequent reason for starvation in cancer patients is anorexia.

Weakness, weight loss, as well as the loss of fat and muscle, are symptoms of cachexia. Patients with tumours that interfere with eating and digesting frequently experience it. Those with cancer who consume food well but are not retaining fat and muscle due to tumour development may experience it.

Some tumours alter how the body utilises particular nutrients. Tumours in the intestines, stomach, and head and neck may alter how the body uses protein, carbs, and fat. Even though a patient may appear to be consuming enough, the body could still not be able to fully absorb the nutrients obtained from the meal. Anorexia and cachexia can coexist in cancer patients.

#### **5.10.3 NUTRITIONAL MANAGEMENT STRESS & TRAUMA CAUSING CANCER**

According to estimates, lifestyle and dietary changes alone can prevent 30–40% of all malignancies. Obesity, nutrient-poor diets such concentrated sweets and processed grain products that affect glucose metabolism and increase the risk of diabetes, low fibre intake, eating red meat, and an imbalance in omega 3 with omega 6 fats are all factors in the increased risk of developing cancer. Consuming plenty of fresh produce as well as flax seed, particularly its lignan fraction, will reduce the risk of developing cancer. The health benefits of allium other cruciferous vegetables are particularly notable, with broccoli sprouts having the highest concentration of sulforaphane. Selenium, calcium, folic acid, the B-12 vitamin, vitamin D, calcium, chlorophyll, & antioxidants such carotenoids (-carotene, -carotene, lycopene, lutein, and cryptoxanthin) are protective components in an aggressive cancer prevention diet. Orally, ascorbic acid has few advantages, but intravenously, it may be quite helpful. Probiotics and oral digestive enzyme supplementation are effective anticancer dietary strategies. A diet constructed in accordance with these recommendations is anticipated to result in at least a 60–70% reduction in breast, colorectal, possibly prostate cancers, possibly even a 40–50% reduction in lung cancer, in addition to similar decreases in malignancies at other locations. A dietary regimen like this would be advantageous for both cancer prevention and cancer rehabilitation.

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### **5.11 Neurological Disorder**

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According to medical terminology, neurological disorders are conditions that affect the spinal cord, brain, and body's nerves. A variety of symptoms can be caused by structural, metabolic, or electrical irregularities in the nervous system, spinal cord, or other nerves. Paralysis, weak muscles, shaky coordination, loss of feeling, convulsions, confusion, pain, and altered degrees of consciousness are a few symptoms. The particular causes of neurological issues can vary, but they may include starvation, brain damage, spinal cord injury, or nerve injury. They may also include

genetic illnesses, congenital anomalies or disorders, infections, way of life or environmental health issues. There are numerous recognised neurological illnesses, some of which are rare but many of which are not. On the other hand, mental disorders are "psychiatric illnesses" significant diseases that typically manifest as anomalies of thought, feeling, or behaviour that cause either distress or function impairment. In the United States, the Nation's Library of Medicine estimates that there are upwards of 600 different neurologic illnesses.

Numerous conditions fall under the category of neurological disability, including epilepsy, learning difficulties, neuromuscular disorders, autism, attention deficit disorder (ADD), brain tumours, and cerebral palsy, to name a few. Congenital neurological conditions are those that exist from conception. Tumours, ageing, injuries, infections, or structural flaws may be the cause of other disorders. All neurological disabilities are the outcome of injury to the nervous system, regardless of the source. How much communication, vision, hearing, movement, and cognition are affected depends on where the injury occurs.

There are numerous nervous system conditions that need to be treated clinically by a doctor or other healthcare provider.

- Spinal Cord Injury, Acute
- Alzheimer's condition
- ALS, or Amyotrophic Lateral Sclerosis
- Ataxia
- Palsy of Bell
- mental tumours
- Brain Aneurysm
- seizures and epilepsy
- the syndrome of Guillain-Barré
- Headache
- Brain Injury
- Hydrocephalus
- Herniated disc disease (lumbar disc disease)
- Meningitis
- Several Sclerosis
- muscle weakness
- cutaneous neuropathies
- Alzheimer's disease
- (Brain Attack) Stroke
- recurring headaches
- Stress Headaches
- Chronic Headaches

- How a Headache Develops
- Migraine Diagnosis and Treatment
- Encephalitis
- Septicaemia
- Types of Neuromuscular and Muscular Dystrophies
- Multiple Sclerosis
- Stroke Overview
- Stroke Types
- Symptoms of a Stroke
- Stroke rehabilitation

### **5.11.1 PATHOPHYSIOLOGY OF NEUROLOGICAL DISORDER**

In neurological practise, functional neurological disorders are frequent. The focus of a novel method for making a positive diagnosis involving this condition is on patterns of truly felt symptoms and indications that exhibit variability over time both within and across activities. Despite being a frequent risk factor for functional neurological impairment, psychological stressors are frequently absent. Functional seizures, motor disorders, persistent perceptual positional dizziness, and functionally cognitive disorder are variations of an illness at the interface of neurology and psychiatry that have similarities in aetiology and pathogenesis. Clinical neurophysiological investigations and other indicators can help with the diagnosis of all four entities because they each have unique characteristics. The creation of an internal symptomatic model as part of a predictive code framework, excessive limbic system activity, and failure of the brain networks that give movement the appearance of voluntariness are all components of the underlying causes of functional neurological disorders. Evidence supports individualised, multidisciplinary treatments that may use techniques from physical and psychological therapy.

The following neurological conditions that affect the CNS:

- Alzheimer's illness (AD) is a neurological disorder marked by deterioration to the parts of the brain involved in cognition, or thinking, learning, and memory. This is mostly caused by the buildup of plaques containing beta-amyloid and tau tangles in the brain. The data is largely in favour of the idea that regular exercise can help AD patients avoid cognitive decline. This is made possible by elements like neurogenesis and anti-inflammatory properties that assist lessen the pathophysiological symptoms of the illness.
- Multiple System Atrophy (MSA) is a chronic, severely disabling condition of the central nervous system (CNS) that is characterised by cerebellar, autonomic, motor, and non-motor symptoms.
- Disorder caused by foetal alcohol exposure
- Rett Syndrome (RTS) is a rare genetic condition that leads to neurodevelopmental defects and profound physical and mental impairment. It affects women frequently.
- Trauma to the brain: TBI is described by Menon et al. as "an alteration in brain function or additional indication of brain pathology, brought about by an external force," and it can affect both children and adults.

- Stroke: Ischemic and hemorrhagic strokes are the two main forms. Haemorrhagic stroke is caused by blood vessel malformations that eventually burst inside the brain, whereas ischemic stroke is mostly caused by arterial blockage in the brain.
- The likelihood of having a stroke depends on a number of risk factors, some of which are controllable (such as physical inactivity, obesity, hypertension, diabetes, smoking, and excessive alcohol consumption) and others of which are not (such as age, sex, and heredity).
- Parkinson's disease (PD), sometimes known as "one of the shaking palsy," is caused by a buildup of lewy bodies and a reduction of neurons producing dopamine in the substantia nigra, or nerve root, of the thalamus. Tremor at rest that subsides with independent motion, rigidity, bradykinesia, hypokinesia, and akinesia are all signs of PD.
- Migraine is a recurrent neurovascular disorder marked by intense, frequently unilateral headaches. Common side effects of this headache include photophobia and nausea.
- Cerebral palsy: As defined by Rosenbaum et al., "Cerebral palsy (CP) characterises a collection of persistent abnormalities of posture and motion, and the resulting activity constraints that are related to non-progressive problems that originated in the developing foetal or infant brain. In addition to subsequent musculoskeletal issues, the motor impairments of cerebral palsy frequently come with disturbances in sensation, perception, thinking, communication, and behaviour.
- Spinal cord injuries (SCI) can either be inflammatory or non-traumatic (for example, stab wounds, car accidents, etc.).
- Multiple Sclerosis: More women than males are affected by this autoimmune, neurological illness. The Charcot's trio of MS symptoms includes nystagmus, intention tremor, and cerebellar dysarthria make up Charcot's triad of MS.
- Dementia

### 5.11.2 CLINICAL SIGNIFICANCE OF NEUROLOGICAL DISORDER

Numerous infectious as well as non-communicable diseases can cause neurological problems. At least 250 trillion disability-adjusted life years (DALYs) were lost to cerebrovascular illness, epilepsy/migraine, neurological degenerative diseases, and infections of the CNS (central nervous system) in 2010, accounting for 5–10% of all DALYs worldwide. The prevalence and severity of neurological illnesses are typically thought to be proportionally highest in low-income nations, with an etiological tendency skewed towards infections of the central nervous system. The epidemiological understanding of neurological illnesses has remained limited in settings with little resources, such as those without diagnostic tools and specialised knowledge<sup>4</sup>. They represented 5-25% of all discharges in sub-Saharan Africa according to hospital-based research over the past 20 years, although nearly all of them were retrospective and carried out in teaching metropolitan hospitals. In the countryside, where thorough data on the incidence and development of neurological conditions is almost non-existent, very few research have been conducted.

### 5.11.3 NUTRITIONAL MANAGEMENT OF NEUROLOGICAL DISORDER

There is no question that eating enough food and getting a variety of dietary components has an impact on how well the brain functions. There is currently a lot of information showing how diet and nutrition can help prevent and treat neurologic symptoms in a variety of pathological disorders. The newly identified effects of dietary variables on changes in neuro-inflammation, epigenetic modification, and mitochondrial dysfunction are significant mechanisms that account for the effects of nutrition on brain health. As examples, we use diseases such as Alzheimer's, Parkinson's, stroke,

epilepsy, injury to the brain, amyotrophic lateral sclerosis (ALL), Huntington's disease, and multiple sclerosis to discuss the current state of the evidence for the effectiveness of various dietary interventions, including dietary supplements and dietary restriction.

It also emphasises the critical role of several potential routes for nutrient delivery to the likelihood of neurologic disease and therapeutic response, including metabolic management, epigenetic alteration, neuro-inflammation, and gut-brain axis. The unique idea that dietary nutrition supplementation alters the metabolism-epigenetics-immunity loop to treat brain dysfunction is highlighted last. The metabolism, epigenetics, and immune networks will be the focus of a novel strategy for overcoming neurological deficiencies.

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## 5.12 Musculoskeletal Disorder

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Muscles, bones, and joints can be impacted by musculoskeletal disorders (MSDs). MSDs consist of:

- Carpal tunnel syndrome and tendinitis
- Bone fractures, osteoarthritis, rheumatoid arthritis (RA), and fibromyalgia
- MSDs are widespread. And as you get older, your risk of getting them rises.

Different MSDs might range in severity. They can occasionally create discomfort and pain that makes daily activities difficult. Early detection and intervention may reduce symptoms and enhance long-term prognosis.

A strategy for evaluation should be created in advance of any actions. Evaluation of WMSD preventive programmes includes a list of potential baseline, manipulate, health outcomes, and organisational change indicators for these programmes.

Muscle, nerve, tendon, joint, cartilage, and spinal disc injuries and disorders are referred to as musculoskeletal disorders (MSD). Conditions known as work-related musculoskeletal diseases (WMSD) include:

The state is largely influenced by the workplace environment and how well work is performed; alternatively due to the conditions at work, the condition either gets worse or lasts longer.

The National Institution for Occupational Health and Safety (NIOSH) of the Centres for Prevention and Control of Diseases (CDC) published an assessment of the evidence regarding work-related MSDs in 1997.

Routine lifting of large objects, frequent exposure to the vibration of the whole routine overhead work, working with the neck in a chronic flexion position, and performing repetitively forceful tasks are a few examples of work circumstances that might cause WMSD. This study found supportive data linking workplace circumstances to MSDs of the head, neck, shoulder, elbow, hand, and wrist, as well as the back.

The Department of Labor's Bureau of Labour Statistics characterises MSDs as muscular skeletal system including connective tissue disorders that arise when the exposure or incident that caused the condition was repetitive motion, overexertion, or body reaction (such as bending, climbing, hopping around, reaching, or twisting). MSDs don't encompass conditions brought on by falls, trips, slips, or other similar occurrences. MSD examples include:

- Rips, sprains, and strains
- Back ache
- Palmar-plantar syndrome

- Hernia

Below, common WMSD examples are discussed.

### **CTS, or carpal tunnel syndrome**

According to the United States Department of Labor's, CTS is a condition of the nervous system in the extremities, which consists of nerves and ganglia that are not part of the spinal cord or brain. Carpal tunnel syndrome, which is caused by compression within the median neuron at the wrist, can cause tingling, numbness, weakening, or atrophy of the hand's and fingers' muscles.

- Up to 1.9 million people may suffer from carpal tunnel syndrome, and between 300,000 and 500,000 procedures are carried out each year to treat it.
- According to the Bureau of Labour Statistics, there were 26,794 CTS instances involving missed workdays in 2001, which equates to a median missed workday of 25 days as opposed to 6 days for everybody non-fatal injury and sickness cases. Most of the cases were white, non-Hispanic, female employees between the ages of 25 and 54 (84%).
- Operators, fabricators, and labourers, as well as technical skills, sales, and administrative support, accounted for over seventy percent of all CTS cases in 2001.

### **Back pain and back injury**

One of the top ten causes of doctor visits is back pain. Between five and ten percent of people develop chronic back discomfort.

The Bureau of Labour Statistics recorded 372,683 incidents of back injuries resulting in missed days from work in 2001. Workers aged 25 to 54 (79%), men (64%), or white, non-Hispanic (70%), made up the majority of cases.

Operators, fabricators, and labourers (38%), as well as precision manufacturing, craft, and repair (17%), accounting for more than 54% of injury to the back cases.

### **Arthritis**

Over 100 rheumatic conditions that influence joints, the tissues around the joints, and additional connective tissue are together referred to as arthritis. Depending on the particular disease form, there can be differences in the type, level of severity, and location of symptoms. A doctor has reportedly informed 46 million Americans that they had arthritis or associated rheumatic illnesses. The most frequent reason for disability in the US is arthritis. Nearly 19 million persons with arthritis are limited in their activities. Younger people make up two thirds of arthritis sufferers.

### **Ergonomics**

The science of ergonomics involves adjusting working circumstances and job requirements to the abilities of the workforce. Ergonomics aims to lessen stress and get rid of illnesses and injuries brought on by overusing muscles, improper posture, and repetitive work. Using technological and administrative controls, a workplace ergonomics programme can seek to eliminate or reduce worker interaction with WMSD risk factors in order to avoid or control accidents and illnesses. Although PPE is occasionally utilised, it is the least efficient workplace control to manage ergonomic risks. Uncomfortable postures, repetition, handling of materials, force, psychological compression, is the process vibration, extreme temperatures, glare, poor illumination, and intensity of exposure are risk factors. For instance, workers who spend a lot of time at a desk may experience ergonomic issues.

#### **5.12.1 PATHOPHYSIOLOGY OF MUSCULOSKELETAL DISORDER**

More than 30% of people worldwide have musculoskeletal pain, which places a heavy burden on

patients, their loved ones, and carers in terms of functional impairment, mental anguish, and impacts on mood, loss of the declaration of independence, and diminished quality of life. Musculoskeletal pain is caused by a variety of peripheral the central nervous system (CNS) cells and mediators, and it is related to the distinct sense of touch of joints, muscles, and bones compared to skin. Cortical remodelling occurs as a result of the interaction between neurons and non-neural cells, such as glial, mesenchymal, and immunological cells, which amplifies and sensitises pain signals.

Additionally, ideas, attitudes, and pain behaviours, as well as sex, age, state of mind, and social circumstances, affect how musculoskeletal pain appears, is interpreted, and is evaluated. This narrative review seeks to provide an overview of the various pathogenic mechanisms causing pain in the muscles and tendons and how these pathways combine to facilitate the change from acute to permanent discomfort.

### **5.12.2 CLINICAL SIGNIFICANCE OF MUSCULOSKELETAL DISORDER**

Doctors ask patients about musculoskeletal problems during a neuromuscular evaluation, but they also search for additional symptoms like fever, chills, loss of weight, rash, pain in the eyes or redness, and signs of heart, lung, and digestive diseases. These additional symptoms could be brought on by or linked to a number of musculoskeletal problems.

#### **Pain**

The most prevalent sign of musculoskeletal problems is pain. Patients are asked to explain the type, location, and intensity of their pain by their doctors. They ask participants to note what makes their pain worse or better and whether it is a new or reoccurring issue. Doctors need to know if the pain is evident upon awakening or builds throughout the day, if it is worse when moving a joint for the first time or after extensive use.

Doctors frequently ask patients to explain the type of pain they are experiencing, such as whether it is intense or dull, aching or burning. They need to know if the pain is felt deep within a joint or if it appears to be affecting other musculoskeletal tissues. Doctors can determine the cause with the help of the kind and where it is of the discomfort.

#### **Stiffness**

The joints of patients with musculoskeletal diseases are frequently stiff, making it difficult for them to move them. People frequently use the expression "stiffness" to denote weakness or great exhaustion (fatigue), but to doctors, "stiffness" refers to trouble moving the joints. This is why doctors ask patients to describe their stiffness explicitly. Doctors distinguish between stiffness and a refusal to move because doing so causes discomfort.

#### **Fatigue**

Another symptom that doctors inquire about is fatigue. When someone is fatigued, they have a strong desire to rest and have so little strength that it is challenging to begin and maintain an activity. Doctors assess patients to separate it from tiredness in order to differentiate it from weakness or the incapacity to move. People who experience fatigue may have a condition that affects many bodily systems, produces inflammation, or interferes with their ability to sleep normally.

#### **Joint unsteadiness**

Joint instability, such as wobbliness and buckling of a joint, can occur in people and is an indication that the ligaments and other supporting structures around the joint are weak. The knee is the joint that buckles the most frequently.

### 5.12.3 NUTRITIONAL MANAGEMENT OF MUSCULOSKELETAL DISORDER

Connective tissue is crucial for maintaining the integrity of joints because it holds our muscles and bones together. This means that anyone who leads such physically demanding lifestyle, including athletes, needs to take care of their connective tissue in order to prevent degeneration, injuries, and joint disorders including arthritis and tendon problems.

The best method to maintain strong connective tissue is to consume a diet low in grain and sugar and high in bone broths, high-quality protein including meats and eggs, lots of vegetables, unpasteurized fermented vegetables, kombucha, fruits and vegetables fruit, and healthy fats.

Your body depends on your dietary intake to keep your musculoskeletal system healthy. The proper nourishment is important for healthy connective tissue growth and repair, thus having it will aid in recovery and prevention. Along with a healthy diet, factors like anxiety, lack of sleep, and susceptibility to environmental contaminants all have an impact on hormone levels. As a result, cortisol levels rise, glucose absorption entering cells is slowed, and the body cannot produce glucosamine. More than just making healthy food choices, leading a positive lifestyle is essential for maintaining good musculoskeletal health.

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## 5.13 IMMUNE DEFICIENCY DISORDER

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The immune system typically defends the body against pathogens and other dangers. But occasionally it veers off course and responds to these threats less effectively. Immune deficiency is the term for this low activity, which reduces your body's ability to fight against illnesses.

It may be brought on by medicine or a sickness. Another possibility is that the genetic condition known as primary immunity deficiency is present from birth. Examples comprise:

SCID stands for severe combination immune deficiency. A hereditary disorder that severely impairs various immune system functions. Most SCID infants pass away from severe infections before they turn one. Some SCID instances can be cured with a bone marrow transplant.

CVID stands for common variable immune deficiency. The immune system generates insufficient antibodies to successfully combat infections because of a genetic flaw. Children with CVID frequently get infections of their nose, eyes, ears, lungs, and other organs. Immunoglobulin injections are used to replenish the lost antibodies as part of the treatment.

HIV/AIDS, short for human immunodeficiency virus and acquired immune deficiency syndrome. Cells from the immune system that ordinarily combat infections are infected by HIV and destroyed. A person becomes increasingly more susceptible to illnesses as their immune system's cell count decreases.

Disorders of the immune system can be either inherited or acquired. You are born with a congenital, and primary, disease. A secondary or acquired disorder is one that develops later in life. Congenital disorders are less frequent than acquired disorders.

The following organs are part of your immune system:

- Tonsils
- Bone marrow
- Lymph nodes
- Spleen

Lymphocytes are processed and released by these organs. These are T cells and B cells, two types of white blood cells. Antigen-based intruders are fought by B and T lymphocytes. B cells manufacture antibodies that are tailored to the illness your body has identified. Some T cells eliminate abnormal or alien cells.

### **5.13.1 PATHOPHYSIOLOGY OF IMMUNE DEFICIENCY DISORDER**

The immune system is weakened by primary immunodeficiency disorders, also known as primary immune-related conditions or primary immunodeficiency, making it easier for infections and other health issues to develop. Many persons with primary immunodeficiency disorder are born without some of their immune system's defences or with a malfunctioning immune system, making them more vulnerable to infections-causing microbes.

More than 300 different types of primary immunodeficiency diseases have been discovered so far. Some kinds can go unreported until maturity because they are so benign. Other forms are severe enough to be identified shortly after the birth of an affected child.

There are numerous primary immunodeficiency illnesses that can be treated to strengthen the immune system. Infections that they are more frequent, more persistent, or harder to treat than those of a person with a regular immune system are one of the most characteristic symptoms of primary immunodeficiency. Opportunistic infections are infections that you might acquire despite having a good immune system.

The signs and symptoms vary from persons to person and depend on the type of first-degree immunodeficiency illness.

### **5.13.2 CLINICAL SIGNIFICANCE OF IMMUNE DEFICIENCY DISORDER**

Immune system defence against foreign or aberrant cells that enter or attack the body (including bacteria, viruses, fungi, & cancer cells) is compromised by immunodeficiency diseases. Unexpected bacterial, viral, and fungal infections as well as lymphomas or other malignancies may arise as a result.

Up to 25% of persons with immunodeficiency disorders also have an autoimmune condition (such as immune thrombocytopenia), which is another issue. The immune system assaults the organism's own tissues in autoimmune disorders. Sometimes the autoimmune illness appears prior to any indications of immunodeficiency.

Immunodeficiency disorders come in two different varieties:

- Primarily genetic and typically inherited, these illnesses are typically apparent at birth. They usually start to show during childhood or early adulthood. Some primary immunodeficiency diseases, including common variable immunodeficiency, are not diagnosed until later in life. Primary immunodeficiency disorders number over 100. They are all fairly uncommon.
- Secondary: These conditions typically manifest later throughout a person's life and are frequently brought on by the use of specific medications or by a different condition, including diabetes or HIV infection. Compared to primary immunodeficiency disorders, they are more prevalent.

Certain immunodeficiency diseases reduce life expectancy. While some improve with or without treatment, others linger throughout life but have no impact on life expectancy.

### **5.13.3 NUTRITIONAL MANAGEMENT OF IMMUNE DEFICIENCY DISORDER**

The immune system's capacity to resist infection is strengthened by a balanced diet. You can do the following things to bolster your immune system:

- Keep a healthy weight.
- Consume a range of foods every day, such as cereals, fruits, vegetables, lean meats, and dairy items.
- Purchase a multivitamin supplement that meets your recommended daily allowance (RDA) in full. RDA's are the daily minimums of nutrients that are necessary for a healthy person.
- You can get assistance from a trained dietitian or your doctor in choosing a nutritious diet.

Most people with immunological disorders can lead regular lives, but there are particular challenges you must confront and go beyond. A chronic condition can occasionally be challenging for the entire family. Make sure to let your healthcare provider know if your immunological illness is generating stress at residence or has impacts on family connections. Your doctor can suggest a professional you can consult. Additionally, there might be support groups whereby one can interact with others who have immunological disorders. For vital educational opportunities as well as ways to connect with others, go to the Immune Deficiency Foundation. If you have an immunological disorder, your insurance company may need to approve any medications you use to treat it.

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## **5.14 GENETIC DISORDER**

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When your genes are affected by a mutation—a negative change to a gene also known to as a pathogenic variant—or when you have the incorrect quantity of genetic material, genetic illnesses can develop. The deoxyribonucleic acid, or DNA, which makes up genes, contains instructions for how cells should function as well as the traits that distinguish each individual.

Each of your biological parents contribute half of your DNA to you, and you might inherit an inherited mutation from one or both of them. Genes can occasionally change as a result of problems with the DNA (mutations). Your chance of getting a genetic condition may increase as a result. While some start exhibiting symptoms at birth, others do so gradually.

Genetic conditions include:

- Chromosomal: This type impacts the chromosomes, which are the internal organelles in each cell that house your genes and DNA. People with these disorders have duplicated or missing chromosomal material.
- These illnesses are complex (multifactorial), resulting from a mix of variations in genes and other causes. Chemical exposure, nutrition, usage of certain drugs, and cigarette or alcohol use are a few among them.
- A single gene mutation causes this group of single-gene (monogenic) diseases.

### **5.14.1 PATHOPHYSIOLOGY OF GENETIC DISORDER**

Understanding how individual genes and DNA function will help you better understand the causes of genetic disorders. Your genes contain a large portion of DNA that tells the body how to build proteins. These proteins initiate intricate cell interactions that support your wellbeing.

A mutation alters the instructions that the genes use to make proteins. There might be protein deficiencies. Or the devices you currently possess don't work properly. Environmental elements, commonly known as mutagens, that may cause genetic mutations include:

- Exposure to chemicals.
- Exposure to radiation.
- Smoking.

- UV radiation from the sun.

#### **5.14.2 CLINICAL SIGNIFICANCE OF GENETIC DISORDER**

The types of disorders, the organs they impact, and their severity all have different symptoms. You might encounter:

- Alterations or abnormalities in behaviour.
- Breathing difficulties.
- Cognitive deficiencies occur when the brain is unable to properly process information.
- Delays in development that affect speech or social abilities.
- Difficulties with digestion and eating, such as a lack of ability to assimilate nutrition or trouble swallowing.
- Anomalies of the limbs or face, such as amputated fingers or a deformed lips and palate.
- Movement abnormalities brought on by weak or inflexible muscles.
- Neurological conditions like epilepsy or stroke.
- Small stature or poor growth.
- Loss of hearing or vision.

#### **5.14.3 NUTRITIONAL MANAGEMENT OF GENETIC DISORDER**

For the benefit of the doctor or nutritionists interested in comprehending the value of basic nutritious management during the medical management of these kinds of disorders, the correlations between hereditary diseases and food are examined. The topics discussed include vitamin D-resistant rickets, lactose intolerance and other carbohydrate intolerance, diabetes, genetic obesity, hyperlipidaemia's, and dyslipidaemia in cystic fibrosis. Dietary restriction and the use of cofactors, which and keto acids inherent inborn errors of the breakdown of amino acids are also treated.

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### **5.15 INFECTIONS**

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When a microorganism, such as a virus, fungus, or bacteria, injures a person's body, an infection results. The body's own immune system can frequently prevent these viruses from proliferating within the body. If not, there could be significant harm.

The microorganism lives off of that person's body and reproduces and colonizes there. These pathogenic tiny organisms are contagious and reproduce swiftly. They can spread through a variety of channels, such as:

- Skin-to-skin contact and body fluid transfer
- Contact with faeces, consuming tainted food or water, inhaling particles in the air or droplets, or contacting a surface that has been handled by a person who is carrying the disease.

Viral, bacterial, parasitic, or fungal infections can all cause infectious illnesses. Transmissible spongiform encephalopathies (TSEs), an uncommon class of infectious disorders, are also present.

- **VIRAL ILLNESSES**

The DNA or RNA that makes up viruses is enclosed in a protective capsid. Viruses cannot replicate on their own because they are considerably smaller than your cells. They enter your cells and employ the equipment inside to replicate themselves.

- **BACTERIAL ILLNESSES**

Bacteria are organisms that have one cell with a little bit of DNA that contains all of their instructions. There are bacteria everywhere, even on our skin and inside of our bodies. Numerous bacteria are beneficial or even benign, but some of them produce toxins that can render you ill.

- **BACTERIAL INFECTIONS**

Like bacteria, fungus come in a wide variety. Your body and they are home to them. You may become ill if your fungus become out of control or if dangerous fungi enter your body by your mouth, nose, or a skin injury.

- **PARASITIC DISEASES**

Parasites live and breed on the bodies of other living things. Worms (also known as and some organisms with just one cell (protozoa) are examples of parasites.

- **Prion disorders and transmissible spongiform encephalopathies (TSEs)**

Prions, defective proteins that affect additional proteins in the human body, typically those in your brain, can lead to TSEs. These proteins accumulate in your body because it can neither use them nor get rid of their homes, which causes illness. An extremely uncommon source of infectious illnesses is prions.

#### **5.15.1 PATHOPHYSIOLOGY OF INFECTIONS**

Infectious disease symptoms vary depending on the ailment. Itching and redness are common localized symptoms of fungi infections. Symptoms of infections that are both viral and bacterial can appear throughout your body, including:

- Fever.
- Chills.
- Congestion.
- Cough.
- Fatigue.
- Headaches and muscle aches.
- Symptoms of the digestive system (vomiting, nausea, and diarrhoea).

#### **5.15.2 CLINICAL SIGNIFICANCE OF INFECTIONS**

There are numerous ways that viral illnesses can spread, depending on the manner of infection. Fortunately, there are usually easy ways to avoid getting infected.

Pathogens frequently enter your body through your mouth, nose, and skin wounds. Infections can spread:

- As you sneeze or cough, from person to person. Droplets from sneezing or coughing can occasionally linger throughout the air.
- From close physical contact, such as kissing or having oral, anal, or vaginal intercourse.
- By utilising other people's utensils or glasses.
- On elements like countertops, phones, and doorknobs.

- From coming into contact with an infected animal's or person's faeces.
- Through animal or bug bites (mosquito or tick).
- From food that has been tainted or prepared incorrectly.

### **5.15.3 NUTRITIONAL MANAGEMENT OF INFECTIONS**

In contrast to concentrating on a few of them in significant quantities, it is crucial to have a range of each of these substances in your dietary regimen. The better your plate looks with a range of options from the list that follows below, the more colourful it will be.

#### **1. Citrus Fruit & Greens for Vitamin C**

White blood cell production is supposed to be increased by eating foods strong in vitamin C, such as grapefruits as well oranges, tangerines, sweet red bell pepper, broccoli, fruit such as strawberries, kale, and kiwifruit, which are essential for battling illness.

#### **2. Root vegetables and greens are sources of beta-carotene**

Vitamin A, an anti-inflammatory vitamins that helps your antibodies react to poisons like viruses, is created when beta-carotene is converted into vitamin A. Beta-carotene is abundant in foods including carrots, kale and spinach, apricots, sweet potatoes, squash, and cantaloupe.

#### **3. Vitamin E: Nuts, seeds, and leafy greens**

Vitamin E, a fat-soluble vitamin, is essential for controlling and bolstering immune system performance. Among the foods high in antioxidant vitamin E include spinach, avocado, nuts, and seeds.

#### **4. Green tea contains antioxidants.**

Antioxidants included in green tea have been demonstrated to improve immune system performance. Additionally, it's loaded with amino acids that can help your T-cells produce germ-fighting substances that lessen body inflammation and support the body's ability to fight infection. Green tea comes as matcha powder, boiling tea, or cold tea.

#### **5. Vitamin D: Sunlight, Fish, and Eggs**

Immune system health and immune response regulation are both aided by vitamin D. Salmon, tuna in canned form, the yolks of eggs, and mushroom are all sources of vitamin D. Additionally, your body can produce vitamin D without just three sessions of 13–15 minutes of sunlight.

#### **5. Vitamin D: Fish, Sun, and Eggs**

The body's immunological response is regulated by vitamin D, which is crucial for immune function. Salmon, tuna in cans, egg yolks, even mushrooms all contain vitamin D. With just 13 to 15 minutes of sunlight three times per week, the human body can also produce vitamin D.

#### **6. Probiotics, Gut Wellness, and Immunity**

Live cultures, commonly referred to as probiotics, are present in a variety of foods, including yoghurt, kombucha, sauerkraut, or kimchi, pickles, soybeans (fermented soy beans), and some varieties of cheese. These foods are supposed to help boost the immune system's ability to fight off illness. The "good bacteria" in your digestive system, known as your microbiome, control how other nutrients and bad bacteria are digested by your organism, making probiotics possibly one of the most crucial components of immunity.

## **7. Garlic - T-Cell Booster, number seven**

Garlic includes components that stimulate cells necessary for combating disease and aid in the regulation of the immune system, among other methods, to assist the body's defences fight viruses. It can help your body create less stress hormones and increase the number of virus-fighting T cells, both of which may assist in maintaining your immune system in tip-top shape.

## **8. Lymphatic Function Boost as well as Red Blood Cells with Vitamin B-6**

In addition to assisting in the maintenance of the lymphatic system, vitamin B-6 is crucial for the production of new, healthy red blood cells. The following foods are excellent sources of vitamin B-6: chicken, turkey, fish from cold waters (salmon and mackerel), chickpeas (classic hummus), bananas, fortified morning cereal, and nutritional yeast.

## **9. Water: Immunity & Hydration**

White blood cells along with additional immune system cells are transported throughout the body via lymph, which is produced in part by water. Foods with a high water content include celery, cucumbers, and watermelon. Try a cup of green tea made with lemon, watermelon, cucumber, or mint-infused water if you have trouble drinking plain water for a powerful immune-boosting brew. Consider maintaining optimum hydration as a technique to facilitate the delivery of immune-stimulating nutrients to your body's target cells.

## **10. Shellfish, chicken, and beans are high in zinc.**

Zinc is required for immune system cells to function as designed. Our bodies neither create nor store the mineral zinc. While oysters contain the largest dietary zinc level, additional alternatives include red meat, beans, chicken (chicken or turkey), shellfish (crab, clam, lobster, and mussels), and poultry (chicken or turkey). Although some breads and fortified cereals also contain zinc, animal-based diets promote the best absorption.

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## **5.16 AIDS**

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Human immunodeficiency virus (HIV) is a virus that targets immune system cells, making an individual more susceptible to various illnesses and infections. It is shared through sharing injection equipment or through direct contact with the bodily fluids of an infected individual, most frequently during sex that is unprotected (sex without the use of a condom or HIV medication to prevent or treat HIV).

HIV can develop into AIDS, which is an acquired immunodeficiency syndrome, if it is not treated. HIV cannot be eliminated by the human body, and there is no HIV treatment that works. Therefore, if a person is infected with HIV, you will always have it.

Antiretroviral therapy, or ART, an effective HIV treatment option, is fortunately available. HIV medications have the ability to significantly lower the viral load, another name for the concentration of HIV within the blood, if taken as directed. The term for this is viral suppression. A person is said to have an undetected viral load if their viral load remains so small that a typical lab is unable to detect it. People with HIV can live long, healthy lives and will not spread the virus through intercourse between themselves and their HIV-negative partners if they take their HIV medications as directed and achieve and maintain an undetectable viral load.

Additionally, there are effective ways to avoid contracting HIV through sexual relations or drug use, such as pre-exposure prophylaxis (PrEP), a drug that people who are at risk for contracting HIV take to avoid contracting HIV through sex or injecting drugs, as well as post-exposure prophylaxis (PEP), a drug that HIV-positive people must take within 72 hours of a potential

exposure to stop the virus from establishing a foothold. Find more about further HIV prevention measures.

#### **5.16.1 PATHOPHYSIOLOGY OF AIDS**

Before becoming AIDS, HIV infection goes through a number of stages. The Centres for the Control and Prevention of Diseases identified the various phases of infection in 1993, and they are as follows:

- Between one and six weeks after contracting the infection, seroconversion sickness develops. The sensation is comparable to having the flu.
- Infection without symptoms - Following the seroconversion the viruses are low because replication moves slowly. The levels of CD4 and CD8 lymphocytes are normal. This stage may last for years at a time and has no symptoms.
- In patients with persistent generalised lymphadenopathy (PGL), the lymph nodes are enlarged for three months or longer without any apparent explanation.
- Infection with symptoms: This stage is characterised by symptoms. There might also be opportunistic infections. The previously AIDS-related complex (ARC) is a group of symptoms and indicators that are thought to be a prodrome or precursor of AIDS.

The pattern of infections that are opportunistic is influenced by genetics and geography. The immune system's rate of deterioration is a second factor. Many opportunistic infections are low virulence and only affect patients with poor CMI levels of survival.

Genetics and previous site of residence also have an impact. For instance, TB is a common reactivation of a latent illness acquired in the place of origin among African HIV-infected individuals living in the UK.

#### **5.16.2 CLINICAL SIGNIFICANCE OF AIDS**

Sexually transmitted infections (STIs) include HIV. Additionally, it can be transferred through sharing needles, injecting illegal substances, and coming into touch with infected blood. Additionally, it can be passed from mother to kid while she is pregnant, giving birth, or nursing. Without treatment, it can take years for HIV to progressively impair the immune system reaching the point where you develop AIDS.

HIV/AIDS has no known cure, however drugs help manage the infection and stop the disease's progression. International organisations are aiming to promote the accessibility of prevention strategies as well as treatment in resource-poor nations. Antiviral therapies for HIV have decreased AIDS fatalities globally.

#### **5.16.3 NUTRITIONAL MANAGEMENT OF AIDS**

If you have HIV, you should pay particular attention to the topic of nutrition and HIV. That's because both the condition and the treatments you take will induce changes in your body. For instance, you can suffer from infections, diarrhoea, or excessive weight loss. Lipodystrophy (fat distribution syndrome), which can alter body composition and raise cholesterol levels, is another frequent change.

You should be receiving care from a medical professional who has experience treating HIV patients, be taking antiretroviral medication, and be aware of special dietary recommendations in order to be healthy. These consist of:

- Whether or not you should eat when taking your medication

- avoid taking calcium supplements along with integrase inhibitors at the same time
- Understanding the precise recommendations for any additional conditions you might be suffering from, such as the diabetic diet if you're suffering from diabetes
- Diet low in fat if cholesterol is high
- Diet reduced in salt if hypertension

Your physical well-being and how you feel can both be enhanced by changing your diet. Here below a few hints that might be useful. You can receive even more advice from a certified dietitian (RD).

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## **5.17 RESPIRATORY PROBLEMS**

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Asthma, chronic pulmonary obstructive disorder, a condition called cystic fibrosis, cancer of the lungs, TB, bronchitis, pneumonia, & emphysema are the most prevalent respiratory illnesses.

While some respiratory conditions are severe, like an infection, and will improve with treatment, others are chronic or develop into chronic conditions that must be controlled.

Chronic respiratory problems can be brought on by a variety of lung disorders. In only the United States, millions of people suffer from chronic respiratory disease. Because lung diseases are classified into a variety of categories, it might be challenging to estimate the total population with lung diseases.

Smoking is the primary avoidable cause for multiple respiratory illnesses, but there are many hereditary and environmental variables that can contribute to lung disease.

### **5.17.1 PATHOPHYSIOLOGY OF RESPIRATORY PROBLEMS**

Acute respiratory distress syndrome, also known as ARDS, pathophysiology is characterized by edema formation, decreased alveolar clearance as well as collapse/derecruitment, decreased compliance, increased pulmonary arterial resistance, and subsequent abnormalities in gas exchange brought on by shunting as well as ventilation-perfusion mismatch. Mechanical ventilation can spread ventilator-associated damage patterns including barotrauma/volutrauma or atelectrauma, particularly in the context of regional illness heterogeneity. Although the early clinical characteristics of lung injury caused by the novel coronavirus SARS-CoV-2 may include more deep low oxygen levels and loss of dyspnea perception accompanied by fewer radiologically-evident lung injury, an observation not previously described in ARDS, it is similar to lung injury caused by other causes of ARDS.

### **5.17.2 CLINICAL SIGNIFICANCE OF RESPIRATORY PROBLEMS**

You may experience breathing difficulties due to a number of illnesses, including asthma, allergies, inflammation, and infections. You can control your breathing issues with the proper diagnosis, treatment, and comprehension of your disease.

Anytime you experience breathing issues, in particular when you also experience chest pain, a persistent cough, or exhaustion, call your doctor straight once. Some situations can need treatment right away. Contact emergency personnel right away if the shortness of their breath is extreme or accompanied by additional symptoms including confusion, chest discomfort, headaches, pain in the jaw, or pain running down your arm.

### **5.17.3 NUTRITIONAL MANAGEMENT OF RESPIRATORY PROBLEMS**

Metabolism is the term used to describe how the body converts food into energy. Food and oxygen are converted into energy as well as carbon dioxide during metabolism. You exhale carbon dioxide, which is a waste product. People with COPD expend more energy just to breathe. Perhaps ten times

as many calories as someone without COPD are needed by your muscles.

Your body receives nutrients from the foods you eat, such as carbs, lipids, and proteins. You might breathe easier if you consume more fat and fewer carbohydrates. For every unit of oxygen needed during the metabolism of carbohydrates, your body creates more carbon dioxide. Your body makes the least when it metabolises fat.

- Just before you eat, rest.
- Eat more slowly and in smaller portions.
- Eat while seated erect.
- Between eating, pause to engage in some deep breathing exercises.
- If you tend to be too exhausted to eat at the end of the day, eat more in the morning.
- Eliminate meals that make you bloated or gassy. They frequently make breathing more challenging.
- Eat four to six modest meals per day. Your lungs can more easily take in air and expel it as a result of your diaphragm being able to move freely.
- Limit liquid intake with meals as well as drink after meals if it makes you think you're too full to eat.
- To avoid sensation full during the day, think about taking a vitamin or mineral at night.

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## 5.18 Let Us Sum Up

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Pathophysiology is among of the medical specialties that is still in high demand today since disease-ending research is a necessity on a global scale. Alzheimer's disease is one of the disorders that is currently the subject of further research. Recognising the underlying causes of this illness is essential for being able to recognise its early stages and receive a diagnosis promptly that will spare the individual from experiencing this ailment.

By definition, clinical significance is a statistical term used to describe the magnitude of a treatment effect in an epidemiological investigation. In research investigations, clinical significance is crucial since it informs the researchers about the most efficient treatments that may be applied in clinical, non-experimental contexts. A treatment is considered clinically important when its results are convincing enough to justify the hassles, expenses, and risks involved, demonstrating that the individual receiving treatment has been returned to normal functioning after a pre-test revealed dysfunctionality. Clinical significance refers to the expected success of a psychiatric or medical treatment and can be seen in both psychotherapy and medicine. Clinical relevance and clinical importance are synonyms.

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## 5.19 Glossary

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|                     |                                                                                                                                |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Exocrine            | :Describes the process of creating enzymes that are immediately released into the intestines in order to put pressure on food. |
| Infiltration by fat | : Development of fat in the liver's parenchymal cells (a sign of liver disease)                                                |
| Incompetence        | : Improper functional load; refers to the pressure imposed by a nutrient or medication in amounts higher than necessary        |
| Hyperlipidaemia     | : High levels of circulation lipid and cholesterol in the blood                                                                |

Incompetence : Improper functioning load

Over and above the normally required amounts, reserve : Store additional amounts in the body.

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## 5.20 Check Your Progress Exercises

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1. What food intake should be followed in order to minimise this risk?

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2. Explain the nutritional management of respiratory disorder?

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3. Elaborate the pathophysiology of infections and genetic disorders?

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4. What kind of nutrients should be provided to patient suffering from cardiovascular diseases?

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5. Mention the pathophysiology and clinical significance of weight imbalance in detail.

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## UNIT-6 : CHILDHOOD PROBLEMS AND DISORDERS

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### Structure

- 6.1 Introduction
- 6.2 Childhood disorder and diseases:
- 6.3 Inborn Errors of Metabolism
- 6.4 Types of Inborn Errors of Metabolism
- 6.5 Common Types of Amino Acid Disorders
- 6.6 Carbohydrate Metabolism Disorders
- 6.7 Fatty Acid metabolism disorder
- 6.8 Let's Sum Up
- 6.9 Check your progress

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### 6.1 INTRODUCTION

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Children's health is a cornerstone of any nation's well-being, and understanding the unique challenges they face is essential for anyone involved in healthcare, education, or care giving. Among the many issues that can affect children early in life, inborn errors of metabolism (IEMs) hold a special place due to their silent but potentially severe impact. These are a group of rare, inherited conditions where the body is unable to properly process certain nutrients because of missing or faulty enzymes. Though they may not be visible at birth, these disorders can lead to serious health complications if not detected and managed in time.

In this unit, we will explore the concept of inborn errors of metabolism as part of a broader discussion on childhood problems and disorders. We will delve into how these metabolic conditions develop, the types of symptoms they cause, and the scientific reasoning behind their diagnosis and management. Students will be introduced to various examples of IEMs such as phenylketonuria (PKU), maple syrup urine disease (MSUD), galactosemia, and fatty acid oxidation disorders. We will also look at how early detection through newborn screening and prompt nutritional interventions can make a significant difference in a child's quality of life.

By the end of this unit, students will be able to:

- Understand the basic concept of inborn errors of metabolism and their genetic basis.
- Identify common types of IEMs and recognize their clinical features.
- Explain how these disorders are diagnosed, especially through newborn screening.
- Describe the treatment strategies, including dietary and medical management.
- Appreciate the importance of early intervention and lifelong care in managing IEMs.

Childhood is often described as the foundation of life. It is during this phase that physical, emotional, social, and cognitive development occurs at an extraordinary pace. Good health in childhood doesn't just ensure a happy and active early life—it lays the groundwork for a productive, fulfilling adulthood. A healthy child is more likely to grow into a healthy adult, and that simple truth places a profound responsibility on caregivers, health professionals, and society at large to prioritize the well-being of children. Yet, the path to healthy growth and development isn't always smooth. Many children face health challenges that range from temporary illnesses to long-term conditions.

While a runny nose or a mild fever might pass in a few days, some childhood diseases have lasting impacts—affecting a child’s ability to grow, learn, and interact with the world. Some of these conditions are visible and easy to diagnose, like malnutrition or infections. Others, like genetic and metabolic disorders, can remain hidden until they begin to interfere with the child’s development. Understanding and addressing childhood diseases is essential not only for the child’s immediate well-being but also for the health of the family and community. Many disorders that begin in childhood—if left untreated—can lead to disabilities, poor academic performance, emotional struggles, and lifelong dependence. Early detection and timely intervention can dramatically alter this trajectory, allowing children to live more independent and productive lives.

Health during childhood is more than just the absence of disease. It includes complete physical, emotional, and social well-being. A healthy child is one who eats well, sleeps soundly, grows at an appropriate pace, learns actively, and interacts happily with others. When this balance is disrupted by disease, the consequences can ripple through every aspect of their development. For instance, a child suffering from a metabolic disorder might not only face physical symptoms like lethargy or vomiting but also experience delays in speech, learning difficulties, or social withdrawal. Childhood health is also a powerful indicator of the future health of a population. Nations that invest in children’s health see better educational outcomes, reduced healthcare costs, and a more productive workforce. This makes childhood disease prevention and early management a public health priority, especially in low- and middle-income countries where access to care may be limited.

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## 6.2 Childhood disorder and diseases

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Childhood is often imagined as a time of joy, discovery, and boundless energy. While this is true for many, not all children enjoy carefree days. For some, childhood is marked by frequent doctor visits, hospital stays, or struggles with conditions that interrupt their growth and development. Childhood disorders and diseases are a significant concern not only for families but also for healthcare providers, educators, and policymakers who realize that early health challenges can shape a child’s entire future. Childhood disorders refer to any illnesses, conditions, or abnormalities that occur during infancy, early childhood, or adolescence. These conditions can be temporary—like a mild infection—or lifelong—such as a genetic disorder. Some conditions are easily visible and diagnosed shortly after birth, while others remain hidden and only reveal themselves as the child grows. Children are not simply “small adults.” Their bodies are still developing, and their immune systems, brains, and metabolic systems are maturing. Because of this, illnesses can present differently in children than in adults and often progress faster if left untreated. Additionally, the emotional and developmental consequences of disease are much greater during childhood, affecting not just physical health but also learning abilities, social relationships, and emotional well-being.

Childhood diseases and disorders are broad and diverse. They can be grouped into a few major categories to better understand their nature:

- **Infectious Diseases:** Childhood is a dynamic and delicate phase of human life, marked by rapid physical, mental, and emotional development. It is during these formative years that children explore the world, build relationships, and lay the foundation for lifelong health. However, childhood is also a time when the body’s immune system is still maturing, making children especially susceptible to infectious diseases. These illnesses, caused by bacteria, viruses, fungi, and parasites, are among the most common and significant threats to child health worldwide. From minor viral infections to life-threatening illnesses, infectious diseases continue to affect millions of children, particularly in regions where access to clean water, healthcare, and vaccination is limited. The prevalence and impact of these diseases underscore the need for early prevention, timely intervention, and sustained public health

efforts.

Infectious diseases in children present in various forms and can affect virtually every system of the body. Respiratory infections are among the most frequent, often leading to absenteeism from school and parental work loss. The common cold, while usually mild, can cause significant discomfort with symptoms such as sneezing, coughing, sore throat, and mild fever. Influenza, or the seasonal flu, is another widespread viral illness that causes higher fevers, body aches, fatigue, and can lead to complications like pneumonia, especially in younger children or those with pre-existing conditions. Pneumonia itself is a serious infection of the lungs and one of the leading causes of death in children under five globally. It can be viral, bacterial, or fungal in origin and often requires urgent medical attention and hospitalization in severe cases. Bronchiolitis, primarily affecting infants, is another lower respiratory tract infection commonly caused by respiratory syncytial virus (RSV). It manifests with wheezing, difficulty breathing, and feeding problems, often requiring supportive care.

Gastrointestinal infections also pose a major health burden among children. Diarrhea and vomiting can quickly lead to dehydration, especially in infants and young children, due to their smaller fluid reserves. Rotavirus, one of the most common causes of severe diarrhea in children under five, has been significantly reduced in many countries through vaccination programs, but it remains a problem where such vaccines are not widely available. Other agents, like norovirus and adenovirus, can spread rapidly in daycare centers and schools, causing outbreaks. Bacterial infections, including those caused by *Salmonella*, *Shigella*, and *Escherichia coli*, often result from consumption of contaminated food or water and can lead to prolonged illness. In some cases, these infections may also trigger serious complications like hemolytic uremic syndrome (HUS), which affects the kidneys. Parasitic infections like giardiasis and amoebiasis, though more common in low-resource settings, can also cause chronic diarrhea and malnutrition if untreated.

Many childhood infectious diseases are vaccine-preventable, which highlights the tremendous value of immunization programs in public health. Vaccines have helped to drastically reduce the incidence of once-common but highly dangerous diseases. Measles, for example, is a highly contagious viral illness that starts with fever, cough, and a distinctive rash. Though preventable through the MMR (measles, mumps, rubella) vaccine, it continues to cause outbreaks in communities with low immunization coverage. Measles can lead to severe complications like pneumonia, encephalitis, and even death. Mumps, another viral disease covered by the MMR vaccine, causes painful swelling of the salivary glands and can sometimes result in complications like meningitis, pancreatitis, or hearing loss. Rubella, or German measles, tends to cause milder symptoms but poses a significant threat to pregnant women, potentially leading to miscarriage or congenital rubella syndrome in infants.

Whooping cough, or pertussis, is a highly contagious bacterial infection known for its severe coughing spells, which can lead to difficulty breathing, vomiting, and exhaustion. This illness is particularly dangerous for infants who have not completed their full vaccination schedule. Diphtheria and tetanus, once widespread and deadly, are now rare in many parts of the world thanks to the DPT vaccine, yet they remain a threat in under-immunized populations. Diphtheria can block the airways and lead to heart and nerve damage, while tetanus causes painful muscle spasms and can be fatal without intensive care.

Beyond respiratory and gastrointestinal infections, skin and soft tissue infections are also common among children. Due to their active lifestyles and tendency for close physical contact, children often experience cuts, abrasions, and skin irritations, making them more

vulnerable to bacterial and fungal infections. Impetigo, a contagious skin infection caused by Staphylococcus or Streptococcus bacteria, typically appears as red sores or blisters on the face and hands. While not life-threatening, it can spread rapidly in groups of children if not treated. Fungal infections like ringworm present as itchy, scaly patches and are easily transmitted through shared items like towels or combs. Scabies and lice, caused by mites and insects respectively, are prevalent in crowded living conditions and result in intense itching and irritation. Though these conditions are not usually dangerous, they cause significant discomfort and can affect a child's self-esteem and social interactions. Ear and eye infections are other common health concerns in children. Otitis media, or middle ear infection, often follows a cold or respiratory infection and can cause ear pain, fever, and temporary hearing loss. Chronic or repeated ear infections may impact language development, especially in younger children. Conjunctivitis, commonly known as pink eye, is inflammation of the eye lining caused by bacteria or viruses. It spreads easily through contact and, although generally mild, requires treatment to prevent further complications and discomfort. In certain cases, infectious diseases can lead to more severe complications, including long-term disability or death. Sepsis, a life-threatening immune response to infection, can occur if bacteria enter the bloodstream and spread rapidly. Meningitis, an infection of the membranes surrounding the brain and spinal cord, is another critical illness that can result from bacterial or viral infections. Symptoms include high fever, stiff neck, vomiting, confusion, and sensitivity to light. If not treated quickly, meningitis can cause permanent brain damage, hearing loss, or death. These severe outcomes emphasize the need for prompt recognition and treatment of childhood infections. The burden of infectious diseases in childhood extends beyond the immediate symptoms. Frequent or prolonged illnesses can interfere with a child's growth and development. Chronic infections or repeated hospitalizations may result in missed school days, poor academic performance, and reduced opportunities for socialization. Children living with chronic infections such as HIV/AIDS face lifelong challenges, including stigma, medication adherence, and immune suppression. In developing countries, the cycle of poverty and disease is particularly vicious—illness reduces educational and income opportunities, which in turn limits access to healthcare and adequate nutrition, making infections more likely and severe. Preventing and managing infectious diseases in children requires a combination of medical, environmental, and social interventions. Immunization remains the cornerstone of prevention, and maintaining high vaccination coverage is essential to protect both individuals and communities through herd immunity. Access to clean water, improved sanitation, and hand hygiene are equally important in preventing the spread of gastrointestinal and skin infections. Educating parents, caregivers, and school personnel about the signs of infection and when to seek care helps ensure early detection and treatment. Nutritional support plays a key role in strengthening the immune system and enhancing resistance to infections. Health systems must also be equipped to manage childhood infections effectively. This includes having trained healthcare workers, essential medicines, diagnostic tools, and referral mechanisms in place. In remote or under-resourced areas, mobile health clinics, telemedicine, and community health workers can bridge the gap. Governments and non-governmental organizations must invest in strengthening primary healthcare systems to ensure that children receive timely and affordable care. Collaboration between sectors—health, education, water and sanitation, and social services—is critical in addressing the multifactorial causes of childhood infections. In the digital age, misinformation about vaccines and treatment options has become a growing challenge. Vaccine hesitancy fueled by myths and fears can lead to decreased immunization rates and resurgence of preventable diseases. Public health campaigns, community engagement, and clear communication from trusted healthcare professionals are essential to build confidence and promote accurate

understanding of infectious diseases and prevention methods.

- **Nutritional Deficiencies and Disorders:** During the early years of life, children experience rapid physical and cognitive changes that require a balanced intake of essential nutrients. However, due to a variety of factors such as poverty, lack of awareness, food insecurity, poor feeding practices, and illness, many children across the world—especially in low- and middle-income countries—suffer from nutritional deficiencies and related disorders. These deficiencies, often termed “hidden hunger,” may not always be immediately visible but have long-lasting effects on a child’s body and mind. According to the World Health Organization (WHO), malnutrition is responsible for nearly 45% of deaths among children under the age of five, which amounts to more than 3 million deaths annually. Nutritional disorders in children are not only a reflection of food availability but also of the quality of nutrition, maternal health, hygiene, and cultural beliefs related to feeding. The most commonly observed deficiencies include protein-energy malnutrition, iron deficiency anemia, vitamin A deficiency, iodine deficiency, and disorders related to a lack of essential micronutrients like zinc, folic acid, and calcium. Understanding these conditions and their root causes is crucial for developing effective interventions and policies that promote child health and well-being.

One of the most significant nutritional disorders in children is protein-energy malnutrition (PEM), which occurs due to insufficient intake of calories and proteins. It manifests in two major clinical forms—marasmus and kwashiorkor. According to UNICEF, one in four children under the age of five globally suffers from stunted growth due to malnutrition, which is often associated with marasmus. Marasmus is characterized by severe wasting of muscles and fat, making the child look emaciated with prominent ribs and thin limbs. It generally results from prolonged calorie deficiency and is often observed in children under five. In fact, PEM is responsible for nearly 2 million child deaths every year. Kwashiorkor, on the other hand, typically results from a lack of adequate protein intake despite sufficient calories and is marked by symptoms such as swollen limbs, enlarged liver, irritability, skin lesions, and thinning hair. In many cases, children may suffer from a mix of both forms, indicating chronic undernutrition. PEM not only stunts growth but also weakens the immune system, making children more susceptible to infections and diseases. Recovery from severe malnutrition requires a combination of therapeutic feeding, medical support, and long-term nutritional rehabilitation involving both the child and the family. The WHO reports that the global prevalence of stunting in children under five years is around 22%, with some regions like Sub-Saharan Africa and South Asia having much higher rates. Iron deficiency anemia is another widespread nutritional issue, particularly among children aged six months to five years. Iron is a vital component of hemoglobin, the protein in red blood cells that carries oxygen to tissues. A lack of sufficient iron leads to anemia, resulting in fatigue, paleness, poor concentration, and reduced physical endurance. It is estimated that nearly 42% of children under five years old are affected by anemia, with iron deficiency being the leading cause. In growing children, anemia can affect brain development, behavior, and school performance. Iron deficiency may result from poor dietary intake, frequent infections, worm infestations, or chronic blood loss. \*\*Studies have shown that children with anemia may experience a reduced IQ and lower academic achievement. In some cases, children consume foods rich in iron but with poor absorption due to lack of vitamin C or high intake of inhibitory substances like tannins in tea. Addressing iron deficiency involves not only providing iron-rich foods such as green leafy vegetables, legumes, meat, and fortified cereals but also improving the overall dietary diversity and sanitation practices. Deworming programs, iron supplementation, and nutrition education are often part of public health strategies to combat childhood anemia. The WHO estimates that 250,000 to 500,000 children

go blind each year due to vitamin A deficiency, with half of them dying within a year of losing their sight. One of the earliest signs of deficiency is night blindness, where the child has difficulty seeing in dim light. If left unaddressed, it can progress to xerophthalmia—a condition characterized by dryness of the conjunctiva and cornea—and may eventually lead to complete blindness. Moreover, vitamin A-deficient children are at a higher risk of severe infections like measles, diarrhea, and respiratory illnesses due to impaired immunity. In fact, vitamin A supplementation has been shown to reduce child mortality by 23%, as it boosts the immune system and enhances recovery from infections. In many countries, vitamin A supplementation programs have been introduced as part of child health initiatives, especially targeting children under five. These programs have proven effective in reducing morbidity and mortality related to preventable infections and visual impairment.

Iodine deficiency, although often overlooked, is one of the leading preventable causes of intellectual disability in children. Iodine is essential for the production of thyroid hormones that regulate metabolism and brain development. A lack of iodine during pregnancy and early childhood can lead to conditions like goiter (enlargement of the thyroid gland), cretinism, and cognitive impairments. According to the WHO, approximately 2 billion people globally are affected by iodine deficiency, with one in three children in the world living in areas with insufficient iodine levels. In school-age children, even mild iodine deficiency can cause reduced IQ and learning difficulties. The most effective public health measure to prevent iodine deficiency is the use of iodized salt—a simple yet powerful intervention that has significantly improved iodine status globally. However, awareness and availability of iodized salt still vary across regions, making continued education and monitoring necessary. The introduction of iodized salt in several countries has led to significant reductions in iodine deficiency-related conditions, with some nations reporting nearly complete eradication of iodine-deficiency disorders. The WHO estimates that 17% of the global population is zinc-deficient, and children with zinc deficiency are more prone to infections like diarrhea and pneumonia, and they may exhibit stunted growth and delayed sexual maturation. Zinc is found in foods such as meat, shellfish, legumes, and whole grains, but the absorption from plant-based sources can be limited. Supplementation during episodes of diarrhea has been shown to reduce the duration and severity of illness and is recommended by global health authorities like WHO and UNICEF as part of the integrated management of childhood illnesses. Zinc deficiency is estimated to contribute to 800,000 childhood deaths each year, primarily due to its role in enhancing immunity and reducing the severity of infections. Other important micronutrients include calcium and vitamin D, both essential for bone health and development. An estimated 1 in 4 children globally suffers from vitamin D deficiency, which can lead to rickets, a disorder characterized by soft, weak bones and skeletal deformities. A deficiency in these nutrients during childhood can lead to rickets, a disorder characterized by soft, weak bones and skeletal deformities. Folic acid and vitamin B12 are also critical, particularly for DNA synthesis and neurological development. Deficiencies can lead to anemia and developmental delays, emphasizing the importance of a balanced and varied diet that includes fruits, vegetables, dairy, grains, and animal products.

The root causes of nutritional deficiencies in children often extend beyond diet alone. Poverty, food insecurity, cultural practices, gender inequality, maternal education, and inadequate health services all contribute to poor nutritional outcomes. According to the United Nations, approximately 45% of children under five suffer from undernutrition, which results from both inadequate food intake and poor-quality diets. In many households, especially in marginalized communities, children may not receive adequate meals due to financial constraints, while traditional beliefs may limit the intake of certain nutritious foods. Additionally, repeated infections such as diarrhea and respiratory illnesses can reduce appetite and nutrient absorption, creating a vicious cycle

between undernutrition and illness. The first 1000 days of life—from conception to two years of age—are particularly critical, as deficiencies during this period can have irreversible consequences on physical and cognitive development.

Addressing childhood nutritional disorders requires a holistic, multi-sectoral approach. Governments and health systems must prioritize maternal and child nutrition through comprehensive policies that include food fortification, nutrition education, breastfeeding promotion, and access to health and sanitation services. School feeding programs, community-based nutrition interventions, and regular screening for malnutrition can also help detect and manage problems early. Data from the World Bank shows that countries investing in child nutrition yield greater long-term economic benefits, with healthier, more productive populations. Empowering families, especially mothers, with knowledge about balanced diets, hygiene practices, and feeding techniques is essential. At the same time, efforts to alleviate poverty, improve agricultural productivity, and ensure equitable access to nutritious foods are fundamental to tackling the underlying causes.

- **Congenital and Genetic Disorders:** Congenital and genetic disorders present unique challenges for children and their families, often influencing a child's growth, development, and overall quality of life from an early age. These disorders can manifest at birth or become evident as children grow, sometimes even going undiagnosed for years. The prime difference between congenital and genetic disorders lies in their origin: congenital disorders are conditions present at birth, which may or may not be inherited, while genetic disorders are caused by abnormalities in the genes or chromosomes and are often passed down from one generation to the next. In childhood, these disorders can significantly alter the trajectory of a child's development, requiring comprehensive medical management, emotional support, and specialized care. It is important to recognize that while many of these conditions may seem overwhelming, with the right intervention, children with congenital and genetic disorders can thrive and live meaningful lives. Early diagnosis, family support, and advancements in medical treatments play a crucial role in managing these conditions and improving the long-term outcomes for affected children.

Congenital disorders are those that are present at birth and can result from a variety of factors, including genetic influences, environmental exposures, infections, and complications during pregnancy. These disorders may vary widely in severity, from conditions that cause minimal developmental delays to those that lead to significant physical or cognitive impairments. One of the most common types of congenital disorders is congenital heart defects. These are structural abnormalities in the heart that occur during fetal development. According to the American Heart Association, approximately 1 in 100 children is born with a congenital heart defect. The severity of these defects varies. Some children may have mild conditions that can be managed with medication or minor surgery, while others may require more intensive treatments, including open-heart surgery. Timely medical intervention and a supportive care plan are essential for managing these conditions and enabling children to lead normal lives. Another well-known congenital disorder is cleft lip and palate, which affects the upper lip and roof of the mouth. The Centers for Disease Control and Prevention (CDC) estimates that 1 in 700 babies is born with a cleft lip or palate worldwide. This condition can affect feeding, speech development, and dental health. Surgery to repair the cleft, along with speech therapy, dental care, and ongoing follow-up, can greatly improve the child's quality of life. With proper care, children with cleft lip and palate can grow up with few long-term complications.

Genetic disorders, unlike congenital disorders, arise from abnormalities in a child's genetic code. These disorders may be inherited from one or both parents or can result from spontaneous genetic

mutations. Genetic disorders often have lifelong implications for a child's health, development, and overall functioning. One of the most widely known genetic disorders is Down syndrome, which occurs when a child inherits an extra copy of chromosome 21. This genetic condition is characterized by intellectual disability, developmental delays, distinct facial features, and sometimes other health problems like heart defects. According to the CDC, approximately 1 in 700 babies born in the United States is affected by Down syndrome. Early intervention, including speech therapy, physical therapy, and specialized educational programs, can greatly improve a child's development and help them reach their full potential. While children with Down syndrome may face some challenges, many lead fulfilling, independent lives with the support of their families and communities.

Cystic fibrosis (CF) is a genetic disorder that affects the lungs, digestive system, and other organs. CF is caused by mutations in the CFTR gene, which leads to the production of thick, sticky mucus that can clog the airways and lead to respiratory and digestive issues. The Cystic Fibrosis Foundation estimates that 1 in 3,500 children in the United States is born with CF. While there is no cure for CF, advancements in treatment have significantly improved life expectancy and quality of life for children with this disorder. Treatment typically involves a combination of respiratory therapy, medications, and dietary support to help manage the symptoms and prevent complications.

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## 6.3 Inborn Errors of Metabolism

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Inborn errors of metabolism (IEMs) are rare but critical genetic disorders that affect how the body processes nutrients and maintains vital biochemical pathways. They are often present from birth and can lead to significant health issues if not identified and managed early. These disorders, while individually uncommon, collectively represent a major area of concern in pediatrics, genetics, and metabolic medicine.

The term "inborn error of metabolism" was first introduced in the early 20th century by Sir Archibald Garrod, a British physician who recognized that some diseases were inherited due to faulty biochemical processes. Essentially, IEMs occur due to mutations in specific genes that encode enzymes responsible for metabolizing proteins, carbohydrates, or fats. When one of these enzymes is missing or defective, the normal metabolic pathway is disrupted, leading to the accumulation of toxic substances or a deficiency in essential compounds.

There are hundreds of different IEMs, each affecting a specific metabolic process. Although the underlying mechanisms differ, they all share a common theme: a tiny genetic error with potentially life-altering consequences.

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## 6.4 Types of Inborn Errors of Metabolism

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Inborn errors of metabolism are broadly classified based on the type of biochemical pathway affected. The most common categories include:

**Amino Acid metabolism disorder:** Our body uses enzymes—special proteins that help speed up chemical reactions—to break down amino acids and use them for energy, growth, and repair. In people with amino acid disorders, there is a mutation in the gene responsible for producing one of these enzymes. As a result, the amino acid may build up in the blood to harmful levels, or the body may be unable to make important substances from it. Either situation can lead to serious health problems if not managed early. Most amino acid disorders are inherited in an autosomal recessive pattern, meaning that a child must receive a faulty gene from both parents to develop the condition.

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## 6.5 Common Types of Amino Acid Disorders

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### 1. Phenylketonuria (PKU)

PKU is one of the most well-known amino acid disorders. It occurs when the body lacks the enzyme phenylalanine hydroxylase, which is needed to break down the amino acid phenylalanine. When phenylalanine builds up in the blood, it becomes toxic to the brain and nervous system.

But in people with PKU, a genetic mutation causes this enzyme to be missing or not work properly. So instead of being converted, phenylalanine builds up in the blood and brain to harmful levels. Over time, this buildup becomes toxic—especially for the brain—and can cause serious developmental and intellectual issues.

PKU is an inherited disorder, passed down from both parents in what's called an autosomal recessive pattern. That means each parent must carry one faulty copy of the gene.

A child who inherits two faulty copies (one from each parent) will have PKU. If a child gets only one faulty gene, they won't develop the condition, but they'll be a carrier. Parents usually don't even know they carry the gene, since carriers are perfectly healthy.

Symptoms:

Thanks to modern newborn screening, most babies with PKU are diagnosed before symptoms appear. But if the condition isn't detected early, symptoms often start within a few months of birth and may include:

- Delays in reaching developmental milestones
- Intellectual disability
- Seizures
- Behavior or mood problems
- Musty smell in the baby's breath, skin, or urine
- Skin rashes or eczema
- Lighter skin and hair, due to decreased melanin

The longer PKU goes untreated, the more severe and permanent these effects can become. That's why early diagnosis is critical. In many countries, newborn screening tests are performed routinely within the first few days after birth. A few drops of blood are taken from the baby's heel and tested for various metabolic conditions, including PKU. If the screening shows high phenylalanine levels, further blood and genetic tests confirm the diagnosis. This process may seem overwhelming for new parents, but early detection can truly change the future of a child born with PKU.

In countries where newborn screening is not widespread, children may not be diagnosed until developmental problems become noticeable—often when some damage has already occurred. There's no permanent cure for PKU yet, but it's very treatable, especially when managed from infancy. The most important tool is dietary management.

1. **Low-Phenylalanine Diet:** Since phenylalanine comes from protein-rich foods, the main approach is to limit protein intake. People with PKU avoid foods like: Meat and fish, Eggs, Dairy products, Nuts and legumes, Bread and grains (in excess). But they don't just stop eating protein altogether—because the body still needs it to grow. Instead, they rely on special medical formulas and low-protein medical foods that are carefully designed to provide just the right nutrients without excess phenylalanine.

2. Tyrosine Supplements: Because tyrosine is not produced adequately in PKU patients, it's often given as a supplement to support healthy brain function.
3. Medications (in some cases) Some people with a milder form of PKU may benefit from a medication called sapropterin (also known as BH4), which can help their bodies use any remaining enzyme activity to break down phenylalanine more effectively. However, not all patients respond to this treatment.
4. Regular Monitoring Managing PKU is a lifelong commitment. Individuals must regularly check their blood phenylalanine levels, especially during early childhood, pregnancy, or any time when growth and brain development are active. Diet may need adjustments depending on age, activity level, and health status.
2. Maple Syrup Urine Disease: MSUD is a rare inherited disorder that affects the body's ability to break down certain amino acids—specifically the branched-chain amino acids (BCAAs): leucine, isoleucine, and valine. These amino acids are important for muscle growth and energy but can become toxic if not properly processed.

In people with MSUD, the enzyme complex known as branched-chain alpha-keto acid dehydrogenase (BCKDH) doesn't work correctly due to a genetic mutation. When this enzyme is deficient or non-functional, the BCAAs and their by-products start building up in the body, especially in the brain, leading to severe health issues. MSUD is passed on in an autosomal recessive pattern, which means: Both parents must be carriers of the faulty gene. A child must inherit two defective copies (one from each parent) to develop the condition. It often runs in families and is more common in certain communities, such as the Old Order Mennonites.

### **Symptoms of MSUD**

Symptoms usually appear within the first few days or weeks of life and may include:

- Poor feeding
- Vomiting
- Weak muscle tone (hypotonia)
- Lethargy
- Seizures
- Delayed development
- A maple syrup-like smell in urine, earwax, or sweat

If untreated, MSUD can quickly lead to coma or death due to brain swelling caused by toxic amino acid levels.

### **Diagnosis**

MSUD is often detected through newborn screening, using a blood test within a few days after birth. If screening shows elevated BCAA levels, more specific tests and genetic analysis are performed to confirm the diagnosis. Managing MSUD requires strict control of protein intake throughout life. Treatment includes:

- A low-protein diet, especially avoiding foods high in BCAAs.
- Special medical formulas that provide essential nutrients without the toxic amino acids.
- Regular monitoring of blood amino acid levels.

- In some cases, thiamine supplements may help, especially in milder forms.

During illness or stress, people with MSUD are at higher risk for a metabolic crisis, where amino acid levels can spike dangerously. In such situations, hospitalization and emergency care are often needed. In some cases, liver transplantation has been used as a long-term solution, as a healthy liver can help restore enzyme activity.

**2. Homocystinuria:** It is another inherited amino acid disorder that may not be immediately obvious at birth but can lead to serious complications if left untreated. Homocystinuria is caused by a defect in the enzyme cystathionine beta-synthase (CBS), which is essential for converting the amino acid homocysteine into another amino acid called cystathionine. When CBS is deficient, homocysteine accumulates in the body and damages the blood vessels, eyes, bones, and brain. There are several types of homocystinuria depending on which enzyme or pathway is affected, but the classic form caused by CBS deficiency is the most common.

Like many metabolic disorders, homocystinuria is inherited in an autosomal recessive pattern. Both parents must carry a faulty gene for the child to be affected.

### Signs and Symptoms

Symptoms may develop gradually and vary widely. Common features include:

- Delayed physical or intellectual development
- Tall, thin body structure with long limbs (similar to Marfan syndrome)
- Lens dislocation in the eyes (ectopia lentis)
- Osteoporosis or fragile bones
- Behavioral or psychiatric issues
- High risk of blood clots, which can lead to strokes at a young age
- Because of the blood clotting risk, homocystinuria can be life-threatening if not diagnosed early.

Diagnosis involves measuring the levels of homocysteine and methionine in the blood and urine. Newborn screening in some countries includes testing for homocystinuria. Genetic testing helps confirm the diagnosis. Management focuses on reducing homocysteine levels to prevent complications. Treatment plans often include:

- Vitamin B6 (pyridoxine): Some people respond well to high doses.
- Betaine: Helps convert homocysteine to a safer compound.
- Folic acid and vitamin B12: Support metabolic pathways.
- Low-methionine diet with special formulas to supply essential nutrients.

With early and consistent treatment, many individuals with homocystinuria can lead normal lives, though they require lifelong dietary control and regular follow-ups.

**3. Tyrosinemia:** Tyrosinemia is a group of rare genetic disorders where the body cannot effectively break down the amino acid tyrosine. There are three main types: Type I, Type II, and Type III, with Type I being the most severe and life-threatening. Tyrosine is broken down in the liver through a series of steps. In Type I Tyrosinemia, the final step is blocked due to a deficiency of the enzyme fumarylacetoacetate hydrolase (FAH). As a result, toxic by-products accumulate, especially in the liver and kidneys, leading to severe organ damage. Tyrosinemia is also inherited in an autosomal

recessive manner. Both parents must carry the gene for the child to be affected.

### Symptoms by Type

#### **Type I (most severe)**

- Onset can be within the first few months of life
- Liver failure or enlargement
- Vomiting, diarrhea, and failure to thrive
- Rickets (soft bones) due to kidney damage
- Neurological crises (pain, muscle weakness, breathing difficulty)
- High risk of liver cancer later in life

#### **Type II (ocular and skin-related)**

- Eye pain or corneal ulcers
- Skin lesions on palms and soles
- Intellectual disability

#### **Type III (rare and less understood)**

- Mild symptoms like mental retardation or seizures
- Often milder liver involvement

Tyrosinemia is detected through newborn screening, blood tests (to check for high tyrosine and succinylacetone levels), and liver function tests. Genetic testing confirms the diagnosis.

Treatment depends on the type but is especially urgent in Type I:

Nitisinone (NTBC): A medication that blocks the harmful by-product buildup, allowing safer tyrosine levels. Low-protein, low-tyrosine and low-phenylalanine diet, Liver transplant may be needed in severe cases or when NTBC is not effective.

With early treatment, especially NTBC and dietary management, children with Type I tyrosinemia can grow up healthy and avoid liver failure.

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## **6.6 Carbohydrate Metabolism Disorders**

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Glycogen Storage Diseases (GSDs): Among the most well-known carbohydrate metabolism disorders are Glycogen Storage Diseases (GSDs). These occur when the body can't properly store or retrieve glycogen, the stored form of glucose. There are several types of GSDs, each resulting from a different enzyme deficiency. One of the most severe forms is GSD Type I, also known as Von Gierke Disease, where the enzyme glucose-6-phosphatase is missing. This enzyme is crucial for releasing glucose from the liver into the blood. Without it, the body cannot maintain stable blood sugar levels, particularly during fasting. Children with this condition often present with symptoms like low blood sugar, enlarged liver, growth delays, and frequent infections. Managing GSD Type I requires strict feeding schedules, sometimes including uncooked cornstarch (a slow-digesting carbohydrate) to maintain blood sugar levels.

Another variant, GSD Type II or Pompe Disease, affects muscle tissues more severely and can cause heart and muscle weakness. Unlike Type I, which primarily involves liver dysfunction, Pompe disease results from a deficiency of the enzyme acid alpha-glucosidase, leading to glycogen

buildup within the muscles. In infants, this can lead to heart enlargement and muscle hypotonia, while in later-onset forms, it may cause progressive muscle weakness. Treatment for Pompe disease may include enzyme replacement therapy, which has greatly improved outcomes.

GSD Type V, also known as McArdle Disease, affects the muscles' ability to access stored glycogen during exercise. This is due to a deficiency in muscle phosphorylase. People with this condition often experience exercise intolerance, muscle cramps, and sometimes even muscle breakdown, which can turn the urine dark red or brown. Though not life-threatening, this condition requires adaptations in physical activity and diet, with patients often benefiting from gentle, consistent exercise and a carbohydrate-rich diet before activity.

**Galactosemia** :Another significant carbohydrate metabolism disorder is Galactosemia, where the body cannot properly metabolize galactose, a sugar found in milk. In classic galactosemia, the enzyme galactose-1-phosphate uridylyltransferase (GALT) is deficient or absent. This leads to the accumulation of toxic substances in the liver, kidneys, brain, and eyes. Symptoms often appear in newborns within days of consuming milk and may include vomiting, jaundice, liver enlargement, and failure to thrive. If not treated promptly, galactosemia can lead to developmental delays, liver disease, and even death. However, with early diagnosis—often through newborn screening—and immediate removal of galactose from the diet, children can live healthy lives, although they may still face challenges related to speech, learning, or fertility.

**Hereditary Fructose Intolerance (HFI)**: it is an another carbohydrate metabolism disorder that involves the enzyme aldolase B, which is necessary for breaking down fructose. Found in fruits, table sugar, and some processed foods, fructose becomes toxic when it accumulates in the body. Symptoms often emerge when infants are introduced to fruits or sweetened foods and can include severe abdominal pain, vomiting, low blood sugar, and liver damage. If the disorder goes undiagnosed, it can lead to seizures or death. Once diagnosed, the treatment is straightforward: a strict, lifelong avoidance of fructose and related sugars. When managed correctly, individuals with HFI can live without significant complications.

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## **6.7 Fatty Acid metabolism disorder**

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**Fatty Acid Oxidation Disorders (FAODs)** occur when the body is unable to properly convert fats into energy, particularly during times of increased energy need. These disorders can cause sudden energy crises that, if unrecognized, may lead to life-threatening complications. Because the body can't switch to fat metabolism, individuals can suffer from dangerously low blood sugar (hypoglycemia), muscle breakdown, heart dysfunction, and even coma.

**Common FAODs** :One of the most common FAODs is Medium-Chain Acyl-CoA Dehydrogenase Deficiency (MCADD). This disorder prevents the breakdown of medium-chain fatty acids, which are a critical source of energy during fasting. Infants with MCADD may appear perfectly healthy until they miss a meal or fall ill. Then, without warning, they can experience vomiting, lethargy, seizures, or sudden death due to hypoglycemia and toxin buildup. Thankfully, newborn screening often detects MCADD before symptoms appear, allowing families to implement preventive measures. Management primarily involves avoiding fasting, providing frequent carbohydrate-rich meals, and giving glucose supplements during illness or stress.

**Long-Chain 3-Hydroxyacyl-CoA Dehydrogenase Deficiency (LCHADD)** is a more complex disorder involving long-chain fatty acid oxidation. It can affect multiple organs, including the liver, muscles, and eyes. Infants with LCHADD may show signs like low blood sugar, heart problems, or liver dysfunction, while older children might experience muscle pain, weakness, or progressive retinal damage. Management includes a special low-fat diet, supplemented with medium-chain

triglycerides (MCT oil), which can be metabolized through a different pathway. Caregivers must also be vigilant during times of illness or fasting to prevent metabolic crises.

Carnitine Transport Defect is another FAOD where the body lacks the ability to transport fatty acids into the mitochondria due to a deficiency of carnitine or its transporter proteins. Carnitine is essential for fat metabolism, and without it, fat cannot be used for energy. Symptoms can include muscle weakness, fatigue, low blood sugar, and heart muscle abnormalities. Treatment typically involves carnitine supplements and a careful dietary plan that emphasizes frequent meals and carbohydrates while avoiding fasting.

There are also rarer FAODs, such as Very Long-Chain Acyl-CoA Dehydrogenase Deficiency (VLCADD) and Trifunctional Protein Deficiency (TFPD), which can have similar symptoms and risks. These disorders highlight how essential fat metabolism is, especially during times when the body is under stress or deprived of food.

Both carbohydrate metabolism disorders and fatty acid oxidation disorders can pose serious risks, especially during infancy and early childhood when the body is growing rapidly and is highly sensitive to energy imbalances. In the past, many of these disorders were diagnosed only after a child became critically ill. Today, thanks to expanded newborn screening, most of these conditions can be detected within the first few days of life—long before symptoms appear. This early detection allows for prompt dietary interventions that can prevent irreversible damage or death. Once diagnosed, these disorders require lifelong management. Parents and caregivers must become experts in nutrition, emergency care, and daily symptom monitoring. Dietitians play a crucial role in developing personalized nutrition plans that meet the individual’s energy and growth needs while avoiding harmful substances. Regular check-ups with metabolic specialists are also essential to monitor progress, adjust treatment plans, and address emerging health concerns.

Proper nutrition is the **main form of treatment** for many metabolic disorders. Below are some of the better-known IEMs and how diet helps to manage them:

Table 1: Inborn error in metabolism and their dietary management

| Condition                               | What Happens                                              | Symptoms                                     | Dietary Management                                     |
|-----------------------------------------|-----------------------------------------------------------|----------------------------------------------|--------------------------------------------------------|
| <b>Phenylketonuria (PKU)</b>            | Trouble in breaking down of phenylalanine (an amino acid) | Developmental delay, seizures, skin rash     | Strict low-phenylalanine diet; special medical formula |
| <b>Maple Syrup Urine Disease (MSUD)</b> | Can't process certain amino acids                         | Vomiting, poor feeding, sweet-smelling urine | Limit branched-chain amino acids; specialized formula  |
| <b>Galactosemia</b>                     | Can't digest galactose (a sugar in milk)                  | Jaundice, vomiting, liver issues             | No dairy; soy or lactose-free formula                  |
| <b>Glycogen Storage Diseases</b>        | Body can't store or use sugar properly                    | Low blood sugar, enlarged liver              | Regular meals, snacks, high-carb uncooked cornstarch   |
| <b>Fructose Intolerance</b>             | Body can't break down fructose (fruit sugar)              | Abdominal pain, vomiting                     | Avoid foods with fructose, sucrose, and sorbitol       |

|                       |                                                  |                              |                                                    |
|-----------------------|--------------------------------------------------|------------------------------|----------------------------------------------------|
| <b>Homocystinuria</b> | Problem breaking down methionine (an amino acid) | Eye and bone problems, clots | Low-methionine diet, B6 and folate supplements     |
| <b>Tyrosinemia</b>    | Difficulty processing tyrosine                   | Liver and kidney issues      | Low-tyrosine/phenylalanine diet; medication (NTBC) |

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## 6.8 Let's Sum Up

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Nutritional deficiencies and disorders in children remain a significant public health concern, with deep implications for a child's survival, growth, and future potential. These issues are not merely medical challenges but reflections of social, economic, and cultural conditions that shape a child's environment. Ensuring that every child receives adequate nutrition is not only a right but a foundation for a healthier and more productive society. By investing in child nutrition, we invest in human capital, reduce health disparities, and pave the way for brighter futures. According to UNICEF, investing in the first 1000 days of life can have a significant impact, ensuring that children grow into healthy, thriving adults capable of contributing positively to society. Infectious diseases continue to pose significant challenges during childhood, especially in low- and middle-income countries where healthcare access and public health infrastructure may be limited. However, the good news is that most of these diseases are preventable, treatable, and manageable with timely interventions. Through a blend of preventive strategies like vaccination, improved sanitation, early detection, and responsive healthcare systems, we can protect children from the harmful effects of infections. Ensuring that every child has the opportunity to grow up healthy and free from the burden of disease is not just a medical goal—it is a moral imperative. A healthy child has the chance to dream, learn, and thrive, and by safeguarding childhood health, we invest in the strength and future of our societies. Congenital and genetic disorders in childhood are complex and often life-changing. However, with early diagnosis, appropriate medical interventions, and a strong support network, children with these conditions can lead fulfilling lives. While the journey may present challenges, advancements in medicine, increased awareness, and societal support can provide children and their families with the tools they need to overcome these obstacles. By recognizing the importance of early intervention, promoting social inclusion, and offering compassionate care, we can help children with congenital and genetic disorders reach their fullest potential and lead happy, productive lives.

born errors of metabolism (IEM) are a group of rare genetic conditions that affect how the body processes nutrients like carbohydrates, proteins, and fats. These disorders are present from birth and usually result from mutations in genes that code for specific enzymes. When an enzyme is missing or doesn't function properly, the normal chemical reactions in the body are disrupted. As a result, toxic substances may build up, or essential products may not be made, both of which can lead to serious health issues.

Though IEMs are rare individually, taken together they affect thousands of children worldwide. Some common examples include phenylketonuria (PKU), maple syrup urine disease (MSUD), galactosemia, and medium-chain acyl-CoA dehydrogenase deficiency (MCADD). These conditions can vary greatly in severity—from mild forms that may go unnoticed for years to severe types that cause life-threatening symptoms in newborns.

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## 6.9 Let us check your progress

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### MCQ

1. What are inborn errors of metabolism (IEMs)?

- A. Infectious diseases
  - B. Nutritional deficiencies
  - C. Genetic disorders affecting metabolism
  - D. Autoimmune conditions
2. Inborn errors of metabolism are usually caused by:
- A. Viral infections
  - B. Enzyme deficiencies or malfunctions
  - C. Lack of physical activity
  - D. Hormonal imbalances
3. Which of the following is a common example of an inborn error of metabolism?
- A. Diabetes
  - B. Hypertension
  - C. Phenylketonuria (PKU)
  - D. Asthma

**ANSWER : C,B,C**

Answer the following question:

1. What are inborn errors of metabolism, and how do they affect a child's health?

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2. List and explain three common inborn errors of metabolism found in children.

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3. What are the primary causes of childhood disorders like phenylketonuria (PKU) and galactosemia? How do they impact a child's development if left untreated?

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4. Explain the treatment strategies commonly used to manage inborn errors of metabolism, focusing on dietary modifications and supplementation.

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5. What are some of the psychological and social challenges children with metabolic disorders might face, and how can these challenges be addressed?

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6. How do fatty acid oxidation disorders differ from carbohydrate metabolism disorders in terms of their impact on a child's energy metabolism?

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## **BLOCK-3      NUTRITION DURING DISORDERS AND DISEASES**

### **INTRODUCTION**

Nutrition during disorders and diseases involves tailoring dietary plans to manage and support the specific health needs and conditions of individuals. This can encompass various approaches, including dietary restrictions, therapeutic diets, and nutritional supplementation, depending on the diagnosis. The objectives are often to manage symptoms, reduce complications, and support overall health and well-being. Nutrition plays a critical role in the prevention, management, and treatment of various diseases and conditions, such as diabetes, heart disease, cancer, gastrointestinal disorders, and food allergies, among others. Dietary plans are typically developed by healthcare professionals, such as dietitians or doctors, to address the unique requirements of each patient's condition.

Nutrition during disorders and diseases is a critical component of medical care, as it can significantly impact the course of a condition, its symptoms, and the overall well-being of individuals.

**Heart Disease:** A heart-healthy diet aims to reduce the risk of heart disease or manage existing conditions like hypertension and high cholesterol. It typically involves reducing saturated and trans fats, limiting sodium intake, and increasing fiber-rich foods like fruits, vegetables, whole grains, and lean proteins.

**Gastrointestinal Disorders:** Conditions like irritable bowel syndrome (IBS), celiac disease, Crohn's disease, and diverticulitis may require specialized diets. This often involves identifying trigger foods and managing symptoms through dietary adjustments.

**Kidney Disease:** Managing protein, phosphorus, and potassium intake is vital for those with kidney disease. Depending on the stage of the disease, dietary protein may need to be restricted, and phosphorus and potassium intake **should be limited**.

Nutrition during disorders and diseases is highly individualized and should be guided by healthcare professionals, particularly registered dietitians or nutritionists. These experts consider the specific diagnosis, nutritional requirements, lifestyle, and personal preferences to develop tailored dietary plans that optimize health, manage symptoms, and improve the overall quality of life for individuals facing various health challenges.

**Unit 8-** Nutrition in hepatic (liver) problems is crucial for managing liver diseases such as cirrhosis, fatty liver disease, or hepatitis. Dietary recommendations typically include limiting sodium intake to manage fluid retention, moderating protein intake to reduce ammonia production, and avoiding alcohol to prevent further liver damage. Adequate calorie intake and a balanced diet are essential to prevent malnutrition and support overall liver function. Dietary plans should be tailored to the specific liver condition and may require ongoing monitoring and adjustments under the guidance of a healthcare professional.

**Unit 9-** Nutrition in renal (kidney) diseases is vital for managing conditions like chronic kidney disease (CKD) or end-stage renal disease (ESRD). Key aspects include controlling protein, phosphorus, potassium, and sodium intake to reduce the burden on the kidneys and manage electrolyte balance. Adequate calorie intake and balanced nutrition are essential to prevent malnutrition. Specialized diets like the renal diet or hemodialysis diet are often prescribed, and fluid intake may be restricted to manage fluid retention. Nutrition plans are tailored to the specific stage of kidney disease and may require ongoing monitoring by a healthcare professional, typically a registered dietitian or nephrologist.

**Unit 10-** Nutrition in renal (kidney) diseases is vital for managing conditions like chronic kidney

disease (CKD) or end-stage renal disease (ESRD). Key aspects include controlling protein, phosphorus, potassium, and sodium intake to reduce the burden on the kidneys and manage electrolyte balance. Adequate calorie intake and balanced nutrition are essential to prevent malnutrition. Specialized diets like the renal diet or hemodialysis diet are often prescribed, and fluid intake may be restricted to manage fluid retention. Nutrition plans are tailored to the specific stage of kidney disease and may require ongoing monitoring by a healthcare professional, typically a registered dietitian or nephrologist.

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## UNIT 7 - IMPORTANCE OF NUTRITION FOR DIFFERENT SPORTS AT DIFFERENT AGES

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### STRUCTURE

- 7.1 Introduction
- 7.2 Energy Requirements
- 7.3 Protein Requirement
- 7.4 Fat Requirement
- 7.5 Carbohydrate Requirement
- 7.6 Vitamins and minerals
- 7.7 Special Concerns
- 7.8 Fluid and Electrolyte
- 7.9 Impact of Nutrition on Athletes' Performance
- 7.10 Role of Nutrition in Overall well-being of Athletes
- 7.11 Sports and Nutrition at Different Ages
  - 7.11.1 Childhood (Ages 6-12)
  - 7.11.2 Adolescent (Ages 13-19)
  - 7.11.3 Young Adults (Ages 36-60)
  - 7.11.4 Middle Age (Ages 36-60)
  - 7.11.5 Senior Citizens (Age 60+)
- 7.12 Let's Us Up
- 7.13 Check Your Progress

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### 7.1 INTRODUCTION

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Successful athletic performance is a combination of proper training and a sensible approach to nutrition. Proper nutrition is a vital consideration for athletes who seek to maximize their performance. A proper diet will provide the proper nutrients and energy for athletic performance, training and healing. It is an integral component to any athletes training and performance program. Athletes need to consume adequate energy during periods of high intensity and/or long duration training to maintain body weight and health by maximizing training effects.

In order to maximize performance, nutritional requirements must be followed. Such requirements ensure that the athlete maintains a desired pace while maintaining health. Nutritional requirements involve consuming adequate fluids, electrolytes and carbohydrate before and during competition. ***(Nutrition Requirements for the athlete Kaley Peterson, Kayla Docken Performance Nutrition and Weight management fall 2014, united state Olympics committee sports dietitians; University of Colorado sports nutrition).***

**Nutritional Goals for athlete are to Ensure:**

- Adequate energy intake to meet the energy demands of training.

- Adequate replenishment of muscle and liver glycogen with dietary carbohydrates.
- Adequate protein intake for growth and repair of tissue, particularly muscle.
- Adequate overall diet to maintain a healthy immune system.
- Adequate hydration.
- Delay fatigue during training and competition.
- Minimization of dehydration during exercise.

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## 7.2 ENERGY REQUIREMENT

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An athlete's energy and nutrient requirements vary with height, weight, age, sex and metabolic rate. Emotional and physical stress of training and competition, combined with hectic travel schedule which affects dietary intake, adequate caloric and essential nutrient intake must be planned carefully to meet requirements for training and fitness. (*Dietetics sixth edition; B.Srilakshmi*)

The caloric intake should be between 3000-6000 kcal depending upon the activity. In proportion to caloric intake, the need for thiamin, riboflavin and niacin increased. To be in energy balance, an athlete needs to consume about the same number of calories that he or she expends on a daily basis. (*Dietetics sixth edition; B.Srilakshmi*). However, actual needs are specific to the individual athlete and need to be fine-tuned with consideration of the athlete's total energy needs, specific training needs and feedback from their training performance.

**Table 7.1: Energy Requirement of an Athlete**

| Physical Activity Level                                           | Kcal/kg/day          | Kcal/day   |
|-------------------------------------------------------------------|----------------------|------------|
| General Physical Activity 30-40 min/day 3 times a week            | Normal Diet<br>25-35 | 1800-2400  |
| Moderate level of intense training 2-3 hours/day 5-6 times a week | 50-80                | 2500-8000  |
| High volume intense training 3-6 hours/day 5-6 times a week       | 50-80                | 2500-8000  |
| Elite athlete                                                     | 150-200              | Upto 12000 |
| Large athlete                                                     | 60-80                | 6000-12000 |

(American Institute of sports and nutrition: Latest guidelines for sports and nutrition 2013)

In India National Institute of Nutrition (NIN), Hyderabad; Netaji Subhas National Institute of Sports (NIS), Patiala; Defense Institute of Physiology and Allied Sciences (DIPAS) have made scientific studies to identify the nutrition needs of Indian athletes. Since 1983 NIN has been advising the Sports Authority of India (SAI), a premier sports agency in the country, as well as the Sports Council in Andhra Pradesh, from time to time, on sports nutrition and preparation of menus for the different sports disciplines.

**Table 7.2: Classification of Sports and Games According to Energy Expenditure**

| Category  | Event                                                                                                                                                                                               |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Group-I   | Power events of higher weight category (80 kg and above) weight lifting, boxing, wrestling, judo, throwing events.                                                                                  |
| Group-II  | Endurance events: marathon, long distance running, and walking road cycling, rowing middle- and long-distance swimming                                                                              |
| Group-III | Team events, athletics and power events of middle weight category (65kg): hockey, foot ball volley ball, basketball, tennis, sprints, jumpers, boxing, wrestling weight lifting, judo and swimming. |
| Group-IV  | Events of light weight category: gymnastics, weight lifting and judo.                                                                                                                               |
| Group-V   | Skill games shooting, archery and equestrian.                                                                                                                                                       |

**Source: National Institute of Nutrition, Hyderabad (India)**

**Table 7.3: Average body weight and energy expenditure Levels assumed and allowances suggested**

| Energy category | Body weight (kg) | Energy Allowances |          | Calories Ratios |         |     |
|-----------------|------------------|-------------------|----------|-----------------|---------|-----|
|                 |                  | KCal/kg/day       | KCal/day | carbs           | Protein | Fat |
| Group - I       | 85               | 70                | 6000     | 55              | 15      | 30  |
| Group -II       | 65               | 80                | 5200     | 60              | 15      | 25* |
| Group - III     | 65               | 70                | 4500     | 60              | 15      | 25  |
|                 |                  |                   |          | 64              | 15      | 21* |
| Group - IV      | 60               | 60                | 3600     | 65              | 15      | 20  |
| Group - V       | 60               | 50                | 3000     | 55              | 15      | 30  |

\* = Glycogen loading

**Source: National Institute of Nutrition, Hyderabad (India)**

### 7.3 PROTEIN REQUIREMENT

Protein is needed for normal cellular functioning as well as synthesis of various body tissues. Athlete tends to have elevated demands for dietary protein intake compared to sedentary individuals. Protein intake equal to 15-20 % of total calories will meet the protein requirements of most athletes. ICMR, 1985, recommends 12-14 % of total energy requirements and upper limit could be placed at 2 g/kg body weight. Consuming more protein than 2.0 g/kg body weight results in increased protein oxidation, urea formation, diuresis and can increase risk for dehydration. (*Dietetics sixth edition; B.Srilakshmi*). Some sports scientists have suggested that endurance and resistance-training exercise may increase daily protein needs up to a maximum of 1.2-1.6 g per kg body weight

(BW), compared to the recommended intake of 0.8 g/kg BW for a sedentary person.

The American College of Sports & Medicine recommends daily protein requirements for strength and endurance athletes of 1.2-1.7 g/kg bodyweight. It is recommended that these requirements are reached through diet alone. Additional supplementation is not necessary, especially when the energy intake is optimal. ACSM general protein guidelines for athletes are 1.3-1.8 g/kg BW and 1.6-1.7 g/kg BW/day for strength-training athletes. Because of the high energy intake of these athletes, these requirements may be met easily.

**Table 7.4: Recommendations for Protein Intake Based on Kilograms Body weight**

| Activity Group                          | gm /kg amount (gm) for a 70 kg Person |         |
|-----------------------------------------|---------------------------------------|---------|
| Sedentary                               | 0.8                                   | 56      |
| Strength trained, maintenance           | 1.0-1.2                               | 70-84   |
| Strength trained, gain muscle mass      | 1.5-1.7                               | 105-119 |
| Moderate intensity endurance activities | 1.2                                   | 84      |
| High-intensity endurance training       | 1.6                                   | 112     |

**Source:** *Burke L, Deakin V: Clinical Sports Nutrition, McGraw-Hill, Roseville NSW2069, Australia, 2000.*

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## 7.4 FAT REQUIREMENT

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The fat requirements of athletes are similar, and are slightly higher than those in non-athletes. It is important to consume adequate amounts of fat to ensure optimal health, maintenance of energy balance, optimal intake of essential fatty acids and fat-soluble vitamins, as well as to replenish intramuscular triacylglycerol stores. The amount of required fat depends largely on the training status and goals of the athletes. The ACSM recommends that daily fat intake for athletes should be 20-35% of total energy intake and that fat intake should not decrease below 20% of total energy intake, as the intake of fat is important for the ingestion of fat-soluble vitamins and essential fatty acids. High-fat diets for athletes are not recommended (*American Institute of sports and nutrition: Latest guidelines for sports and nutrition 2013*).

Major source of energy 25 to 30% of total calories should come from fat and less than 10% of total calories should come from saturated fats. Cholesterol intake should be less than 300 mg/day, Average American diet provides 37% of total calories from fat (*Indian Council of medical research, ICMR 2009*)

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## 7.5 CARBOHYDRATE REQUIREMENT

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During intense exercise carbohydrate stored in muscles and liver (glycogen) is predominant fuel source. During prolonged exercise fat stores are predominant fuel source. Fitness level of the well-trained endurance athletes burn fat more efficiently and spare limited glycogen stores. Carbohydrates is a major fuel source for the muscles of athletes and they should ingest 6 to 10 gm/kg/day or 60 to 70% of total calories should come from carbohydrates. Complex carbohydrates (starches) are preferable for athletes.

### **During exercise**

Athletes should consume 25 to 30 gm of carbohydrate for every 30 minutes of exercise.

## After exercise

Athletes should consume 1.0 to 1.5 gm/kg immediately post exercise and again one hour later to replace muscle glycogen stores, to prevent gradual depletion of muscle glycogen stores over time caused by repetitive daily bouts of heavy exercise to decrease muscle breakdown.

## Why Complex Carbohydrates?

Compared to ingesting simple carbohydrates, complex carbohydrates should be preferred:

- For improved performances increase muscle glycogen stores which delays fatigue.
- Promotes faster stomach emptying that causes less stomach upset and indigestion.
- Leads to lower blood sugar and insulin levels.
- Provides other beneficial nutrients like fiber, vitamins and minerals

*(Indian Council of medical research, ICMR 2009)*

**Table 7.5: Daily needs for fuel and recovery for athletes**

| Activity  |                                                       | Daily carbohydrate intake target |
|-----------|-------------------------------------------------------|----------------------------------|
| Light     | Low intensity or skill-based activities               | 3-5g/kg/day                      |
| Moderate  | Moderate exercise program (eg 1hr/ day)               | 5-7g/kg/day                      |
| High      | Endurance program 1-3 hr/ day moderate-high intensity | 6-10g/kg/day                     |
| Very high | Extreme commitment 4-5hr/day moderate-high intensity  | 8-12g/kg/day                     |

**Source: nutrition and Athletic performance – Joint position statement American college of Sports Medicine, Academy of Nutrition and Dietetics and dieticians of Canada. MSSE 2016**

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## 7.6 VITAMINS AND MINERALS

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Strenuous bouts of prolonged exercise and heavy training, particularly aerobic exercise, stress the body both physically and mentally. Adequate intakes of energy, protein, iron, copper, manganese, magnesium, selenium, sodium, zinc, and vitamins A, C, E, B6 and B12 are particularly important for health and performance (*Nutrition for Athletes : A practical guide to eating for health and performance prepared by the Nutrition Working Group of the International Olympic Committee (Revised and updated in February 2010)*). These nutrients, as well as others, are best obtained from a varied and wholesome nutrient-rich diet based largely on vegetables, fruits, beans, legumes, grains, lean meats, dairy foods and healthy oils.

No evidence in U.S. studies that taking vitamin and mineral supplements improves athletic performance. Vegetarian athletes are at risk for being deficient in vitamins B12, D, riboflavin, iron, zinc and calcium. Athletes who are strict vegetarians should take a multivitamin to prevent deficiencies and a calcium supplement (1000 mg/day) to help prevent bone loss (*Indian Council of medical research, ICMR 2009*)

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## 7.7 SPECIAL CONCERNS

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**IRON :** Some athletes may develop iron deficiency and this will impair performance. Unexplained fatigue, especially in vegetarian athletes, should be explored. Routine use of iron supplements is not wise: too much is just as harmful as too little. Self-medication with iron supplements may not address the real causes of an athlete's fatigue or other issues of poor eating and may do more harm than good.

**CALCIUM :** Calcium is important for healthy bones, especially in adolescents and in female athletes, so it is important to ensure adequate calcium intake.

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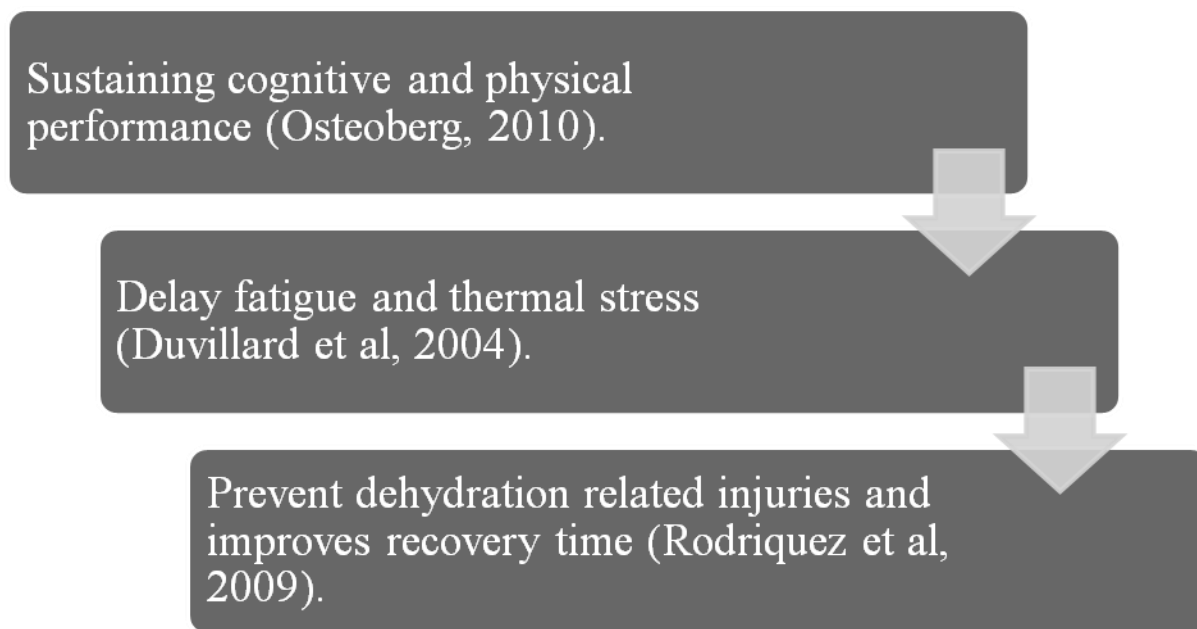
## 7.8 FLUID AND ELECTROLYTE

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Beyond attempting to regularly consuming a healthy, varied and well-balanced diet, athlete should also focus on adequate and appropriate consumption of fluids and electrolytes. These nutrients also have the immediate effect on performance.

Water probably has a great effect on athlete performance than any other nutrient. Most people obtain around two third of their water intake from drinking fluids and between 20-40 % from solid foods. On the other hand, athletes must obtain as much as 90% of their water intake by drinking water (*Dietetics sixth edition; B.Srilakshmi*). They should drink plenty of fluids (e.g., water, juice, milk, sport drinks) throughout the day. They must drink regularly during training and competition – typically, older adolescents and adults can comfortably consume up to 1.4 –1.8 liters or so per hour.

Rehydration is very important for athletes



**Fig 7.1 Hydration is essential for athletes**

Therefore, fluid intake protocols have been recommended for athletes [*American Dietetic association(ADA), 2000; SAI, ILSI & NIN, 2006; Lal, 2006*].

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## 7.9 IMPACT OF NUTRITION ON ATHLETES' PERFORMANCE

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Nutrition plays a paramount role in sports, impacting athletes' performance, recovery, and overall well-being. Proper nutrition is crucial because it provides the body with the necessary nutrients and energy to excel in various athletic endeavors. Here's an elaboration on the importance of nutrition in

sports:

### **1. Energy Source:**

- Carbohydrates: Carbohydrates are the body's primary source of energy, especially during exercise. Athletes rely on stored glycogen (carbohydrate stores) to fuel their workouts and competitions. Adequate carbohydrate intake ensures that athletes have the energy to perform at their best.

### **2. Muscle Health and Repair:**

- Protein: Protein is essential for muscle repair, growth, and maintenance. Athletes, particularly those engaged in strength training or endurance sports, require an adequate intake of protein to recover from workouts and support muscle development.

### **3. Optimal Performance:**

- Micronutrients: Vitamins and minerals play crucial roles in various physiological processes. Deficiencies can negatively impact performance. For example, iron is vital for oxygen transport in the blood, and a deficiency can lead to fatigue and reduced endurance.

### **4. Hydration and Thermoregulation:**

- Water: Staying hydrated is fundamental for athletic performance. Dehydration can lead to reduced endurance, muscle cramps, and impaired cognitive function. Proper hydration also regulate body temperature during exercise.

### **5. Improved Endurance:**

- Carbohydrate Loading: In endurance sports like marathons and cycling, proper carbohydrate loading in the days leading up to an event can significantly improve endurance by increasing glycogen stores.

### **6. Enhanced Recovery:**

- Post-Exercise Nutrition: Consuming a balanced meal or snack after exercise, which includes carbohydrates and protein, aids in muscle recovery, glycogen replenishment, and reduction of post-exercise soreness.

### **7. Body Composition:**

- Weight Management: Proper nutrition helps athletes to maintain an optimal body composition, which is crucial for sports that require a specific weight-bearing activities.

### **8. Mental Focus and Cognitive Function:**

- Fuel for the Brain: The brain requires a steady supply of glucose (from carbohydrates) to maintain focus, decision-making, and reaction time during sports.

### **9. Injury Prevention:**

- Bone Health: Adequate intake of calcium and vitamin D supports strong bones and reduces the risk of stress, fractures and other bone-related injuries in sports.

### **10. Immune Function:**

- Nutrient Support: Proper nutrition helps to maintain a robust immune system. Athletes are susceptible to illnesses due to intense training, and nutrient deficiencies can weaken immune defenses.

### **11. Reduction of Inflammation:**

- Anti-Inflammatory Foods: Some foods, such as those rich in antioxidants and omega-3 fatty

acids, have anti-inflammatory properties. Consuming these foods can reduce exercise-induced inflammation and promote recovery.

### **12. Long-Term Health:**

- Chronic Disease Prevention: Maintaining a healthy diet during an athletic career can reduce the risk of chronic diseases later in life, ensuring athletes' long-term health and well-being.

### **13. Sport-Specific Requirements:**

- Different sports have unique nutritional demands. For example, endurance athletes require a higher intake of carbohydrates, while strength athletes may need more protein. Tailoring nutrition to the specific sport optimizes performance.

### **14. Mental Well-Being:**

- Proper nutrition contributes to mental well-being, reducing stress and anxiety, and promoting a positive mindset. Athletes often perform better when they are mentally and emotionally balanced.

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## **7.10 ROLE OF NUTRITION IN OVERALL WELL-BEING OF ATHLETES**

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Nutrition plays a crucial role in the performance and overall well-being of athletes across various sports. Different sports have unique demands on the body, and as a result, the nutritional requirements can vary significantly. In this detailed explanation, we will explore the importance of nutrition for different sports and how it impacts athletes' performance and recovery.

### **1. Endurance Sports (e.g., Marathon Running, Cycling, Triathlon):**

Endurance sports require athletes to sustain physical activity over extended periods. Proper nutrition is essential for these athletes to maintain energy levels, improve endurance, and enhance recovery. Key considerations include:

- Carbohydrates: Endurance athletes rely heavily on carbohydrates to fuel their workouts. Carbohydrates are stored in muscles and the liver as glycogen, which is the primary energy source during prolonged exercise. A diet rich in complex carbohydrates is essential for maintaining glycogen stores.
- Protein: Protein is necessary for muscle repair and recovery. Endurance athletes should ensure an adequate intake to prevent muscle breakdown during prolonged exercise.
- Hydration: Staying hydrated is critical to prevent dehydration and maintain performance. Electrolytes like sodium, potassium, and magnesium are also important for muscle function.
- Fats: While carbohydrates are the primary energy source, fats are utilized during low-intensity and prolonged exercise. A balanced intake of healthy fats is essential.

### **2. Strength and Power Sports (e.g., Weightlifting, Powerlifting, Sprinting):**

Athletes require explosive strength and muscle power. Nutrition is crucial for muscle development, recovery, and maintaining strength levels. Key considerations include:

- Protein: Protein is essential for muscle repair and growth. Athletes in these sports often require higher protein intake to support muscle protein synthesis.
- Carbohydrates: Carbs are needed for energy, especially during intense training sessions. Timing carbohydrate intake around workouts can enhance performance.
- Caloric Surplus: Many strength and power athletes aim for a caloric surplus to support muscle growth. However, it's important to ensure these extra calories come from nutrient-

dense sources.

- Hydration: Proper hydration is essential to maintain strength and power levels and prevent cramping during intense workouts.

### **3. Team Sports (e.g., Soccer, Basketball, and Football):**

Team sports involve a combination of endurance, strength, and agility. Nutrition is vital for maintaining energy levels throughout a game and facilitating recovery between matches. Key considerations include:

- Carbohydrates: Athletes need carbohydrates for sustained energy during games. Proper carbohydrate intake can also prevent fatigue in the later stages of a match.
- Protein: Protein is important for muscle repair and recovery between games. Athletes should aim to consume protein-rich meals post-match to aid recovery.
- Hydration: Staying hydrated is crucial due to the physical demands and sweating during games. Proper hydration helps maintain cognitive function and physical performance.
- Electrolytes: In sports with high sweat rates, athletes may require electrolyte replenishment to prevent dehydration and maintain performance.

### **4. Combat Sports (e.g., Boxing, MMA, and Wrestling):**

Combat sports demand a balance of strength, endurance, and weight management. Nutrition is vital for maintaining the right weight class, optimizing energy levels, and promoting rapid recovery. Key considerations include:

- Weight Management: Athletes often need to cut or gain weight to compete in specific weight classes. Proper nutrition strategies are essential for achieving this safely.
- Protein: Protein is crucial for muscle repair, especially after strenuous training sessions and bouts.
- Carbohydrates: Carbs are important for energy and stamina during training and competition.
- Hydration: Staying hydrated is essential to prevent fatigue and maintain cognitive function during matches.

### **5. Gymnastics and Figure Skating:**

These sports require a unique combination of strength, flexibility, and endurance. Nutrition is important for maintaining a lean physique while supporting physical demands. Key considerations include:

- Balanced Diet: Athletes must consume a balanced diet to support overall health and body composition.
- Caloric Intake: Proper caloric intake should be monitored to avoid energy deficits that can impair performance.
- Calcium and Vitamin D: These nutrients are crucial for bone health, which is particularly important in sports where weight-bearing on bones is high.

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## **7.11 SPORTS AND NUTRITION AT DIFFERENT AGES**

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Nutrition plays a vital role in sports performance and overall health, and its importance can vary depending on an individual's age and the specific sport they participate in. Here, the significance of nutrition is discussed for different sports at different age groups, highlighting how nutritional needs

evolve over time.

### **7.11.1 CHILDHOOD (AGES 6-12)**

During childhood, nutrition is critical for growth, development, and establishing healthy habits that can last a lifetime. Participation in various sports at this age promotes physical fitness and social development.

- Importance of Nutrition: Children need a well-balanced diet to support growth, strong bones, and overall health. Nutrient-dense foods like fruits, vegetables, whole grains, lean proteins, and dairy products are essential.
- Hydration: Staying hydrated is crucial, especially during physical activities. Water is the primary source of hydration, and children should be encouraged to drink it regularly.
- Timing: Consistent meal and snack timing helps to maintain energy levels throughout the day and support recovery from sport activities.

Nutrition plays a critical role in the development and performance of children aged 6 to 12 years who engage in various sports and physical activities. During this stage of life, children are growing rapidly, both physically and mentally, and their nutritional needs are different from those of adults. Here's an elaboration on the importance of nutrition for different sports during childhood:

#### **1. Growth and Development:**

- Physical Growth: Proper nutrition is essential for supporting the physical growth that occurs during childhood. Nutrients like protein, calcium, vitamin D, and essential fatty acids are crucial for bone development and muscle growth.
- Cognitive Development: Good nutrition supports cognitive development, which is important for learning, memory, and problem-solving skills. A well-balanced diet rich in vitamins and minerals is essential for brain development.

#### **2. Energy Needs:**

- Physical Activity: Children are naturally active, and their energy expenditure can vary depending on the sport or physical activity they engage in. Nutrition provides the energy required to fuel these activities and maintain overall vitality.
- Carbohydrates: Carbohydrates are the body's primary energy source. Children involved in sports need an adequate intake of complex carbohydrates from sources like whole grains, fruits, and vegetables to sustain energy levels during practices and games.

#### **3. Muscle Health:**

- Protein: Protein is essential for muscle growth, repair, and maintenance. Children need an appropriate amount of protein in their diet to support the development of lean muscle mass, especially if they participate in sports that involve strength and endurance.

#### **4. Hydration:**

- Importance of Hydration: Staying hydrated is crucial for children participating in sports, as they are more prone to dehydration due to increased sweating. Proper hydration helps maintain performance and prevents heat-related illnesses.
- Water vs. Sports Drinks: In most cases, water is sufficient for maintaining hydration during sport activities. Sports drinks with electrolytes may be necessary for prolonged or intense activities, but they should be consumed in moderation due to their sugar content.

## **5. Recovery and Growth:**

- **Post-Exercise Nutrition:** After physical activities, it's important to provide children with a balanced snack or meal that includes carbohydrates and protein. This aids in muscle recovery and replenishes glycogen stores.

## **6. Weight Management:**

- **Balanced Approach:** Nutrition should promote a balanced approach to weight management in children. Instead of focusing solely on weight loss or gain, the emphasis should be on providing adequate nutrients to support growth and development.

## **7. Mental and Emotional Well-Being:**

- **Nutrient-Dense Foods:** A diet rich in nutrient-dense foods can positively impact a child's mental and emotional well-being. Proper nutrition supports mood stability, concentration, and overall emotional health.

## **8. Sport-Specific Considerations:**

- **Tailored Nutrition:** The nutritional needs of children can vary based on the sport they participate in. For example, endurance sports may require a higher intake of carbohydrates, while strength-based sports may necessitate more protein.
- **Individualized Plans:** Coaches and parents should work together to create individualized nutrition plans for young athletes based on their specific sport and performance goals.

### **7.11.2 ADOLESCENCE (AGES 13-19)**

During adolescence, growth spurts and increased physical activity demand specific nutritional considerations. Many athletes begin to specialize in sports during this period.

- **Importance of Nutrition:** Proper nutrition is essential for growth, muscle development, and optimizing sports performance. Adolescents need sufficient calories, protein, and essential nutrients.
- **Protein:** Protein intake becomes more critical as muscle development accelerates. Lean sources like poultry, fish, beans, and low-fat dairy are beneficial.
- **Carbohydrates:** Carbohydrates provide energy for sports activities. Balanced carbohydrate intake helps in maintaining energy levels and supports recovery.
- **Hydration:** Adolescents should be educated on proper hydration practices to prevent dehydration during sports activities.
- **Supplementation:** Adolescents should consult with healthcare professionals before considering supplements, as some may be needed to fill nutrient gaps, such as vitamin D or iron.

Adolescence is a critical period of physical and emotional development, and nutrition plays a significant role in the growth, performance, and overall well-being of teenagers involved in various sports. During these years, young athletes experience rapid changes in their bodies, and their nutritional needs can vary based on the sport they participate in. Given below the elaboration on the importance of nutrition for different sports during adolescence (ages 13-19):

### **1. Growth and Development:**

- **Puberty:** Adolescence is marked by puberty, a period of rapid growth and development. Proper nutrition is essential to support these changes, including increases in height, muscle

mass, and bone density.

- Calcium and Vitamin D: These nutrients are crucial for bone health during adolescence. Teenagers should consume an adequate amount of dairy products, leafy greens, and fortified foods to support bone development.

## **2. Energy Needs:**

- Active Lifestyle: Many teenagers are highly active and participate in sports or physical activities. Proper nutrition provides the energy needed for both daily activities and sports performance.
- Carbohydrates: Carbohydrates are the primary energy source for physical activities. Athletes should consume complex carbohydrates like whole grains, fruits, and vegetables to fuel their workouts and competitions.

## **3. Muscle Health:**

- Protein: Adequate protein intake is vital for muscle development, repair, and recovery. Teen athletes, especially those in strength-based sports, require sufficient protein to support muscle growth.

## **4. Hormonal Changes:**

- Nutrient Balance: Adolescents experience hormonal changes that can affect their appetite and nutritional needs. A balanced diet with a variety of nutrients helps regulate hormones and maintain overall health.

## **5. Hydration:**

- Fluid Balance: Proper hydration is crucial for teenagers engaged in sports, as they are at risk of dehydration due to increased sweating. Dehydration can impair performance and lead to heat-related illnesses.
- Electrolytes: For athletes in sports with high sweat rates, electrolyte balance becomes important. Sports drinks with electrolytes may be necessary for prolonged or intense activities.

## **6. Recovery and Growth:**

- Post-Exercise Nutrition: After workouts and competitions, teenagers should consume a balanced meal or snack that includes carbohydrates and protein to aid in muscle recovery and glycogen replenishment.

## **7. Weight Management:**

- Healthy Approach: Adolescents may be concerned about weight management, but it's crucial to approach this topic with a focus on healthy eating habits rather than extreme diets or restrictions.
- Energy Balance: Teen athletes should aim for an appropriate energy balance that supports their level of physical activity. Severe caloric restrictions can hinder growth and athletic performance.

## **8. Sport-Specific Considerations:**

- Nutritional Variability: Nutrition requirements can vary significantly depending on the sport. For example, endurance athletes may need more carbohydrates, while those in weight-based sports may require additional protein.

- Individualized Plans: Coaches, parents, and nutritionists should collaborate to create individualized nutrition plans for adolescent athletes based on their specific sport, training intensity, and performance goals.

## **9. Education and Awareness:**

- Nutrition Education: Adolescents should receive education on nutrition and the importance of making healthy food choices. This knowledge can help them make informed decisions about their diet.

## **10. Mental and Emotional Well-Being:**

- Balanced Diet: A well-balanced diet that includes essential nutrients that can support mental and emotional well-being, aiding in mood stability and cognitive function.

### **7.11.3 YOUNG ADULTS (AGES 20-35)**

Young adults often engage in various sports, from recreational to competitive levels. Nutrition remains crucial for performance, recovery, and overall health.

- Importance of Nutrition: Proper nutrition supports peak performance, muscle maintenance, and injury prevention. A balanced diet rich in vitamins, minerals, and antioxidants is essential.
- Carbohydrates: Carbohydrate intake should be tailored to the specific sport and training intensity. Complex carbs help sustain energy levels.
- Protein: Protein remains crucial for muscle repair and recovery, especially in athletes engaged in strength training.
- Hydration: Adequate hydration is vital, with electrolyte balance being particularly important for endurance athletes.
- Meal Timing: Proper timing of meals and snacks around workouts can enhance performance and recovery.

Young adulthood, typically spanning from ages 20 to 35, is a time when individuals are often at their physical peak. For athletes in this age group, nutrition continues to be a critical factor in sports performance, recovery, and overall health. Here's an elaboration on the importance of nutrition for different sports during young adulthood:

#### **1. General Health and Fitness:**

- Nutrient-Dense Diet: Young adults should maintain a balanced, nutrient-dense diet to support overall health and well-being. This includes adequate servings of fruits, vegetables, whole grains, lean proteins, and healthy fats.
- Weight Management: Proper nutrition helps maintain a healthy body weight, which is essential for reducing the risk of chronic diseases and supporting an active lifestyle.

#### **2. Athletic Performance:**

- Energy Needs: Young athletes in this age group often have high energy expenditure due to intense training and competition schedules. Nutrition provides the energy required to fuel workouts and optimize performance.
- Carbohydrates: Carbohydrates remain a primary source of energy. Athletes should tailor their carbohydrate intake to the specific demands of their sport and training intensity.
- Protein: Adequate protein intake is crucial for muscle repair and growth, which is especially

important for strength and endurance athletes.

- Hydration: Proper hydration is essential to maintain cognitive function and physical performance during training and competition.

### **3. Muscle Health:**

- Resistance Training: Young adults often engage in resistance training to build and maintain muscle mass. Protein intake should be optimized to support muscle recovery and growth.

### **4. Recovery:**

- Post-Exercise Nutrition: After intense workouts or competitions, young adults should consume a balanced meal or snack that includes carbohydrates and protein to aid in muscle recovery and glycogen replenishment.

### **5. Sport-Specific Considerations:**

- Sport Variability: The nutritional needs of young adult athletes can vary significantly depending on the sport they participate in. For example, endurance athletes may require more carbohydrates, while those in strength-based sports may prioritize protein.
- Individualized Plans: Young adults should work with nutritionists and coaches to create individualized nutrition plans based on their specific sport, training volume, and performance goals.

### **6. Injury Prevention and Recovery:**

- Nutrition for Healing: Injuries are common in sports, and proper nutrition can support the healing process. Nutrients like vitamins C and D, protein, and zinc are important for tissue repair and immune function.

### **7. Mental and Emotional Well-Being:**

- Mood and Cognitive Function: Nutrition can impact mood stability and cognitive function. A balanced diet with essential nutrients supports mental and emotional well-being, which is important for performance and overall quality of life.

### **8. Long-Term Health:**

- Disease Prevention: Proper nutrition choices during young adulthood can have a lasting impact on long-term health. A diet rich in antioxidants, fiber, and healthy fats can reduce the risk of chronic diseases.

### **9. Diet Quality:**

- Quality vs. Quantity: Focus should be on the quality of the diet, emphasizing whole, minimally processed foods, rather than just calorie counting.
- Micronutrients: Paying attention to micronutrients (vitamins and minerals) is essential to ensure optimal health and performance.

### **10. Lifestyle Factors:**

- Sleep: Nutrition and sleep are closely related. Young adults should prioritize a healthy diet to support quality sleep, which is vital for recovery and overall health.
- Stress Management: Stress can impact eating habits and digestion. Young adults should practice stress management techniques to support their nutritional goals.

### **7.11.4 MIDDLE AGE (AGES 36-60)**

As individuals age, the importance of nutrition for sports shifts towards maintaining overall health, managing weight, and preventing injuries.

- **Importance of Nutrition:** Nutrition helps maintain muscle mass, bone density, and joint health. A balanced diet with an emphasis on whole foods becomes essential.
- **Protein:** Adequate protein intake supports muscle maintenance and repair, which can be critical as muscle mass naturally declines with age.
- **Calcium and Vitamin D:** These nutrients become increasingly important for bone health.
- **Hydration:** Maintaining proper hydration remains crucial for joint health and overall well-being.

Middle age, spanning from ages 36 to 60 years, is a period marked by various physical changes, including a gradual decline in muscle mass, bone density, and metabolic rate. Nutrition continues to play a crucial role in sports performance, recovery, and overall health during these years. Here's an elaboration on the importance of nutrition for different sports in middle age:

#### **1. General Health and Fitness:**

- **Nutrient-Dense Diet:** Middle-aged individuals should prioritize a balanced, nutrient-dense diet to support overall health. This includes an emphasis on fruits, vegetables, whole grains, lean proteins, and healthy fats.
- **Weight Management:** Proper nutrition helps maintain a healthy body weight, which is essential for reducing the risk of chronic diseases and supporting an active lifestyle.

#### **2. Athletic Performance:**

- **Energy Needs:** Middle-aged athletes may have changing energy requirements due to shifts in metabolism. Nutrition remains important for fueling workouts and optimizing performance.
- **Carbohydrates:** Carbohydrates continue to be a primary source of energy. However, middle-aged athletes may need to adjust their carbohydrate intake based on their changing activity levels and metabolic rate.
- **Protein:** Adequate protein intake is vital for muscle maintenance, repair, and recovery. Protein needs may increase due to age-related muscle loss (sarcopenia).
- **Hydration:** Proper hydration is essential to maintain cognitive function and physical performance during training and competition.

#### **3. Muscle Health:**

- **Resistance Training:** Middle-aged athletes benefit from resistance training to combat age-related muscle loss. Protein intake should be optimized to support muscle maintenance and growth.

#### **4. Recovery:**

- **Post-Exercise Nutrition:** After workouts or competitions, middle-aged athletes should consume a balanced meal or snack that includes carbohydrates and protein to aid in muscle recovery and glycogen replenishment.

#### **5. Sport-Specific Considerations:**

- **Sport Variability:** Nutrition needs can vary significantly based on the sport. Middle-aged

athletes should tailor their nutrition plans to their specific sport, training volume, and performance goals.

- Individualized Plans: Working with nutritionists and coaches to create individualized nutrition plans is crucial to address age-related changes and optimize performance.

## **6. Injury Prevention and Recovery:**

- Nutrition for Healing: Injuries become more common with age. Proper nutrition supports the healing process, and nutrients like vitamins C and D, protein, and zinc are important for tissue repair and immune function.

## **7. Joint and Bone Health:**

- Calcium and Vitamin D: Middle-aged athletes should pay attention to calcium and vitamin D intake to support bone health and reduce the risk of osteoporosis.
- Joint Health: Omega-3 fatty acids, found in fish and flaxseeds, can help reduce inflammation and support joint health, which is important for sports involving impact or repetitive motions.

## **8. Long-Term Health:**

- Disease Prevention: Proper nutrition choices during middle age can impact long-term health. A diet rich in antioxidants, fiber, and healthy fats can reduce the risk of chronic diseases like heart disease and diabetes.

## **9. Diet Quality:**

- Quality vs. Quantity: Focus on the quality of the diet, emphasizing whole, minimally processed foods. Paying attention to micronutrients (vitamins and minerals) is essential for overall health.

## **10. Lifestyle Factors:**

- Stress Management: Managing stress is crucial for overall well-being. Stress can impact eating habits and digestion, so middle-aged athletes should practice stress management techniques.
- Sleep: Nutrition and sleep are closely related. Prioritizing a healthy diet can support quality sleep, which is vital for recovery and overall health.

### **7.11.5 SENIOR CITIZENS (AGES 60+)**

In the senior years, nutrition continues to play a critical role in maintaining health, preventing age-related diseases, and supporting an active lifestyle.

- Importance of Nutrition: Proper nutrition can help manage chronic conditions, support immune function, and preserve muscle mass.
- Protein: Adequate protein intake is essential to prevent muscle loss, which can lead to frailty and reduced mobility.
- Fiber: Fiber-rich foods help with digestion and can assist in managing common digestive issues in older adults.
- Hydration: Staying hydrated becomes even more important as the body's ability to regulate thirst may diminish.

Nutrition continues to be of great importance for senior citizens aged 60 and above who participate in various sports and physical activities. As individuals age, they experience unique physiological

changes that can impact their nutritional needs and sports performance. Here's an elaboration on the importance of nutrition for different sports in senior citizens:

### **1. General Health and Fitness:**

- **Nutrient-Dense Diet:** Seniors should prioritize a nutrient-dense diet to support overall health and vitality. This includes an emphasis on fruits, vegetables, whole grains, lean proteins, and healthy fats.
- **Weight Management:** Maintaining a healthy body weight is crucial for preventing chronic diseases and promoting an active lifestyle in later years.

### **2. Athletic Performance:**

- **Energy Needs:** Aging can lead to a decrease in metabolic rate and muscle mass, affecting energy requirements. Nutrition is still vital for providing the energy needed for physical activities.
- **Carbohydrates:** Carbohydrates continue to be essential for energy, but seniors may need to adjust their intake based on activity levels and metabolic changes.
- **Protein:** Protein intake becomes increasingly important for seniors to support muscle maintenance and recovery. Resistance training can help counter age-related muscle loss.
- **Hydration:** Proper hydration is essential to maintain cognitive function and physical performance, as seniors are at risk of dehydration.

### **3. Muscle Health:**

- **Resistance Training:** Senior athletes benefit significantly from resistance training to combat age-related muscle loss. Adequate protein intake becomes crucial for muscle maintenance and growth.

### **4. Recovery:**

- **Post-Exercise Nutrition:** Seniors should focus on consuming a balanced meal or snack with carbohydrates and protein to aid in muscle recovery and glycogen replenishment.

### **5. Sport-Specific Considerations:**

- **Sport Variability:** Nutrition needs vary based on the specific sport or physical activity. Seniors should tailor their nutrition plans to suit their chosen activity, training volume, and performance goals.
- **Individualized Plans:** Consulting with nutritionists and coaches to create personalized nutrition plans is essential, as these experts can help address age-related changes and optimize performance.

### **6. Injury Prevention and Recovery:**

- **Nutrition for Healing:** Seniors are more prone to injuries, and nutrition plays a crucial role in the healing process. Nutrients like vitamins C and D, protein, and zinc are important for tissue repair and immune function.

### **7. Joint and Bone Health:**

- **Calcium and Vitamin D:** Seniors should continue to pay attention to calcium and vitamin D intake to support bone health and reduce the risk of osteoporosis.
- **Joint Health:** Omega-3 fatty acids, found in fish and flaxseeds, can help reduce inflammation

and support joint health, which is important for sports involving impact or repetitive motions.

### **8. Long-Term Health:**

- Disease Prevention: Nutrition choices in senior years can significantly impact long-term health. A diet rich in antioxidants, fiber, and healthy fats can reduce the risk of chronic diseases such as heart disease and diabetes.

### **9. Diet Quality:**

- Quality vs. Quantity: Focus on the quality of diet, emphasize whole, minimally processed foods. Micronutrients (vitamins and minerals) are essential for overall health.

### **10. Lifestyle Factors:**

- Stress Management: Managing stress is vital for overall well-being. Stress can affect eating habits and digestion, so seniors should practice stress management techniques.
- Sleep: Nutrition and sleep are interconnected. A healthy diet can support quality sleep, which is essential for recovery and overall health.

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## **7.12 LET US SUM UP**

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Proper nutrition is crucial for athletes to perform optimally, recover from training, prevent injuries and illnesses, and maintain overall health. It involves balancing carbohydrates for energy, protein for muscle repair and growth, adequate hydration, and consuming a varied, nutrient-dense diet. Individual nutrition plans tailored to the athlete's sport, training demands, age, and health status are recommended. Consulting sports nutritionists or registered dietitians can provide personalized guidance on meal plans, nutrient timing, supplementation, and adjusting the diet based on changing needs across different life stages. Nutrition combined with appropriate training forms the foundation of athletic success and long-term well-being.

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## **7.13 CHECK YOUR PROGRESS**

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### **Short Questions**

1. Why is nutrition important for athletes?
2. Name two key nutrients essential for endurance sports.
3. What is the role of hydration in sports performance?
4. Mention one difference in nutritional needs between children and adults in sports.
5. List one example of a pre-workout meal.

### **Long Questions**

1. Explain the importance of nutrition for athletes participating in endurance and strength-based sports.
2. Discuss how the nutritional requirements differ for children, adolescents, and adults engaged in sports.
3. Describe the role of macronutrients (carbohydrates, proteins, and fats) in optimizing athletic performance.
4. Analyze the impact of hydration and electrolyte balance on sports performance and recovery.
5. Elaborate on the planning of a balanced diet for a young athlete engaged in competitive sports.

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## UNIT-8 : NUTRITION IN FABRILE CONDITION

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### STRUCTURE

- 8.1 Introduction
- 8.2 Types of Fever
- 8.3 Metabolic Changes During Fever
- 8.4 Principle of Diet
- 8.5 General Dietary Considerations
- 8.6 Typhoid
  - 8.6.1 Symptoms And Signs
  - 8.6.2 Principles of Diet
  - 8.6.3 Dietary Suggestions
- 8.7 Influenza
- 8.8 Malaria
- 8.9 Tuberculosis
  - 8.9.1 Clinical Features
  - 8.9.2 Treatment
  - 8.9.3 Modification of Nutrients
  - 8.9.4 Dietary Management
  - 8.9.5 Prevention
- 8.10 Let Us Sum Up
- 8.11 Check Your Progress

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### 8.1. INTRODUCTION

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In this unit, we will discuss about the fever, different types of fever and metabolic changes during fever. By studying different types of fever and metabolic changes during fever, you can gain insights into how the diet should be modified in order to meet the demand of the body. This knowledge helps in understanding diet in typhoid and tuberculosis etc.

#### Objectives

You will be able to:

- Learn about the types of fever and metabolic changes during fever
- Understand about the dietary modification during fever such as typhoid and tuberculosis

The term "infection" refers to when pathogenic microorganisms like bacteria, fungus, protozoa, rickettsiae, or viruses enter into the human body. Through simple contact as well as airborne particles released while sneezing and coughing, the pathogenic agent can be spread via an infected individual or carrier.

Any infectious sickness can be accompanied with fevers, which are often brought through bacterial

or viral outbreaks. Fever may also develop as a consequence of a tumour, an antigen-antibody response, or transplant rejection.

All infections trigger a catabolic reaction, including those that are subclinical regardless of a fever: infection promotes the production of interleukin 1 from leukocytes, which leads to hormonal changes; the amino acids are mobilised from muscle cells, which depletes protein reserves from muscle tissue; and the utilisation of the amino acids for the production of glucose in the liver, which results in nitrogen being produced and eliminated via urination.

In the course of an acute infection, a temporary drop in plasma concentrations of a mineral such as Zn or a rise in the quantity of flowing interleukins might have an impact on hunger. Vomiting and discomfort in the abdomen are prominent signs associated with other diseases like gastroenteritis. Ulcers in the mouth and throat soreness are the primary causes of loss of appetite in people with HIV. An inadequate appetite is additionally affected by depression and mental wellness. Some of the micronutrients are poorly absorbed such as vitamins that are fat soluble such as vitamin E and A along with fats, proteins, carbs. Faecal fat protein losses can vary from 20 to 40 % with infections due impaired metabolism of fat and proteins.

If the temperature is extreme and there is significant tissue breakdown, the calorie demand can

be as high as 50% or even more. The main goal of treating the diseased person is to locate and get rid of the foreign organism. Antibiotics are frequently recommended by doctors. The status of vitamins and minerals can fluctuate as an outcome of all these medications, and micronutrients which influence their efficacy.

Fever is an increase in the body's temperature that is beyond the normal range. There is controversy over the highest level of normal temperature, which varies between 37.5 and 38.3 °C (99.5 and 100.9 °F). Fevers have been demonstrated not to rise above 41 to 42 °C (105.8 to 107.6 °F). Other acronyms for fever are pyrexia and febrile action. A fever is the body's natural reaction to a virus or other pathogen in the blood, in which the body's natural rate of metabolism is enhanced. When a fever first appears, a person experiences intense muscular contractions and a cold. Thus, more heat is produced, and efforts are made to conserve it. A person feels warm and flushed and may start sweating when the temperature returns to normal.

Fever is a common sign that is connected to a variety of chronic and infectious diseases. A fever can be brought on by a wide variety of medical disorders, from insignificant to possibly quite severe. In addition to non-infectious causes, this covers viral, bacterial, and pathogenic infections. This is distinct from hyperthermia. If the body produces excessive heat or doesn't lose sufficient heat, hyperthermia results in a rise in the body's temperature above normal. One of the most typical signs of illness is fever. Antigen-antibody interactions, transplant rejections, and malignancies are examples of endogenous causes.

Fever can also be brought on by external factors (exogenous) like bacteria, viruses, fungus, and pathogens. Fever treatment does not seem to affect results, despite the fact that it is a valuable defence mechanism for combating the cause. Fever of unknown cause is a persistent fever that remains unexplained in spite of repeated regular clinical enquiries.

The foreign substance activates the phagocytic cells and liberates pyrogens when the individual is infected by the exogenous agent, which in turn stimulates the production of prostaglandin and the thermoregulatory centre in the hypothalamus, causing the rise in temperature.

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## 8.2 TYPES OF FEVER

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The types of fever vary depending on the underlying cause and specific causative agent involved.

**Continuous fever:** In cases of typhoid, meningitis, pneumonia, or UTI, the body temperature remains above normal across the entire day and does not vary by more than 1 degree in a 24-hour period. A unique fever trend associated with typhoid is the Wunderlich curve of typhoid fever, which features a slow incremental ascend and an elevated plateau.

**Intermittent fever:** For example, in cases of malaria, septicemia, etc., the rise in temperature lasts merely a short time before returning to normal.

**Remittent fever:** The daily high temperature swings and slides by more than 1 degree celsius all over the day.

Short term or Brief episodes of fever, like those commonly observed in colds, influenza, and tonsillitis, versus persistent fever seen in cases of tuberculosis.

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## 8.3 METABOLIC CHANGES DURING FEVER

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- A spike in metabolic rate equal to 13% for every degree celsius rise in body temperature (7% for every one-degree Fahrenheit); this spike is also brought on by restlessness, which results in a significantly higher caloric requirement.
- Reduction in both glycogen and adipose tissue reserves.
- The kidneys have to work harder due to increased protein catabolism.
- Higher levels of sweating and waste elimination, which leads to a more rapid loss of bodily fluids.
- The level of potassium and sodium excretion is enhanced.

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## 8.4 PRINCIPLE OF DIET

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During fever, more calories are required. It is necessary to provide enough proteins, carbohydrates, fats, vitamins, and minerals. Drinking more water and other liquids is recommended. Green vegetables, fresh fruits, and dairy products with minimal fat should be given preference in the diet. These foods boost the body's general immunity since they are packed with vital vitamins. These dietary changes can help strengthen the body's defence against infection and additionally help to avoid these kinds of illnesses.

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## 8.5 GENERAL DIETARY CONSIDERATIONS

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### Energy:

When there is a fever or infection, the basal metabolic rate escalates, enhancing the amount of energy required. The number of calories needed increases with restlessness. In the beginning, the patient may only be able to consume 600 to 1,200 kcal per day; however, this is thought to be raised as soon as feasible.

### Protein:

The loss of muscle results from tissue damage during fever, hence the person must be given adequate protein. If a person's fever is persistent, they should take 100 g of protein or more. When there is a large calorie intake, this will be used most effectively. In addition to the normal meals, protein-rich beverages can be consumed.

**Carbohydrates:**

A large intake of carbohydrate helps to store the body's glycogen. It is better to consume glucose that is less sweet and more easily absorbed into the bloodstream. As long as there are no dietary constraints such as those associated with diabetes, other sugars including jams, jellies, and custard made from sugarcane are an excellent substitute.

**Fats:**

The consumption of calories can be quickly boosted by using fats wisely, but fried foods and sugary pastries may cause an unnecessarily longer period of digestion. It is best to stay away from fast food, fried foods, heavy sugary foods, confectionary, and saturated fats. PUFA and MUFA can be considered as best options.

**Minerals:**

Salty soups and broths, as well as heavy salting of food, are effective ways to ensure an adequate amount of minerals such as sodium and chloride. Milk and juices made from fruits are both comparatively excellent suppliers of minerals. Blood iron levels drop sharply during the initial stages of an infection as iron is transported to the liver for storage. This change aids in the battle against the infection by limiting the invading microorganism access to the body's iron which they need for metabolic processes.

In fact, giving significant amounts of oral or intravenous iron can make the infection more serious. As the illness clears up without treatment; the liver will add iron back to the blood.

**Vitamins:**

It appears that the demand for both vitamin A and ascorbic acid elevates with fever, just as the demand for the B-complex vitamins enhances proportionally with a rise in calorie intake. Antibiotics and other medications taken orally can prevent gut bacteria from generating B-complex vitamins, which requires a brief medication for vitamin supplementation.

**Fluid:**

To make up for the fluid lost through perspiration and to allow for enough urine to be produced removing wastes, a lot of fluid intake is necessary. Everyday needs range from 250 to 5000 ml. soups, drinks, fruit juices, and water, among others.

In most cases, dehydration is not a concern until a person experiences vomiting, diarrhoea, or extreme perspiration. When such losses take place, a person may require as much as 2.5 to 5 litres of fluid each day. The hormonal changes that come along with fever may also affect individuals to hold fluids in the body. Overload of fluid may result from the administration of fluids in various situations.

- For the initial period of time, people should only consume fluids, preferably juices, and plenty of water. When you have a fever, water intake is crucial. Make sure to drink enough fluids, which should amount to approximately three litres per day. Water speeds up recovery and aids in eliminating toxins from the body.
- It is recommended for well-being to drink a glass of juice made from fresh oranges at intervals of three hours. Citrus juice contains a lot of vitamin C, which boosts immunity and strengthens the body's capacity to combat an infection.
- Fruit diets are simpler to digest and packed with nutrients that accelerate the healing process. A

healthy diet should contain fresh fruits which include grapes, apples, oranges, peaches, pineapples, and lemons.

- Fruit beverages that come in tins or cans should not be consumed because they have additives that may slow healing.
- It is crucial to supplement fluid diets with solid foods because most fluid diets are bulky and out of proportion to their calorie and nutritional levels. When compared to solid foods, a liquid diet can occasionally cause stomach dilation that can progress to the point of significant discomfort.
- The patient must be placed on a soft diet that includes boiled eggs, steamed vegetables, vegetable soups, oatmeal, and khichri after the fever is gone.
- Oatmeal with vegetables and ginger is calming when fever due to infection as its smooth texture, ease of digestion, and potent anti-inflammatory qualities.
- Fever requires specific foods to be avoided such as fried foods, uncooked foods, chicken, and junk food. These meals can be hard to digest and may put an undue load on the digestive system, which is already underdeveloped.

### **Intervals of feeding:**

Small amounts of food consumed every two to three hours will ensure appropriate nutrition without ever placing an undue strain on the digestive system. If patients are given three meals a day and bedtime feedings, many of them will eat more as they get better.

Antibiotic and medication therapy have significantly reduced the extent of many fevers, and dietary requirements tend to be readily supplied. Smaller meals of soft or liquid food thought to be supplied if needed at frequent intervals because the patient's appetite is frequently very weak during an acute fever. It's important to consume enough salt and liquids. Foods rich in protein and calories should be preferred if the illness lasts longer than a few days.

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## **8.6. Typhoid**

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Typhoid is a highly infectious disease that exclusively affects humans and causes an acute, fever for shorter period of time. Typhoid occurs by the bacteria *Salmonella typhi*, and paratyphoid B by *Salmonella schottmulleri*. The disease is transmitted by the faeces and urine of patients as well as disease carriers. The disease-transmitting flies or by the patients' or carriers can contaminate the drinking water, milk, or food.

Water does not promote the growth of *typhoid bacilli*, however some can last for around 7 days. In ice and ice cream, they might last for more than a month. Milk does not taste or look different when typhoid bacilli are present. A health risk is posed by vegetables that have been cultivated in wastewater or cleaned with water that has been contaminated.

The typical incubation time is 10 to 14 days. But based on the quantity of bacteria consumed, it might last just a few days or as long as three weeks.

The bacterium attaches to the epithelial layer of the intestinal wall in the small intestine, penetrates this layer, multiplies in the mesenteric lymphnodes, and ultimately enters the bloodstream to cause the disease. Endotoxin is released here as a consequence of the disintegration of the bacteria by antibodies, resulting in signs that are more widespread, such as fever. Some bacteria enter the gut through the bile ducts and gall bladder, where they are released and produce a secondary infection that can result in diarrhoea. The discharge of bacteria may last for weeks, and some people can become chronic carriers.

### 8.6.1. SYMPTOMS AND SIGNS

Peyer's patches (flat patches) of lymphatic tissue that are located in the small intestine but predominantly in the ileum are the site of infection in typhoid fever. The disease is marked by a persistent, severe degree of intestinal inflammation. Intestinal ulcers can also develop, and haemorrhage and spleen enlargement are also possible. The patient may experience severe stomach pain, constipation, or diarrhoea. The patient can suffer from headaches, anorexia, and lowered intestinal absorption of various nutrients.

### 8.6.2. PRINCIPLES OF DIET

Typhoid sufferers are advised to follow a bland, high-calorie diet that is also high in protein, carbohydrates and fibre.

### 8.6.3. DIETARY SUGGESTIONS

Typhoid is treated with the same general dietary guidelines as fevers. Following a clear fluid diet initially, a full fluid and soft diet is offered. The patient may not be able to consume enough calories and protein on liquid diets. Soft food can be provided when the patient gets better. Liquid diets might help patients fulfil their demand for water and electrolytes because the febrile period can disrupt their fluid homeostasis.

#### **Foods to be included**

Sugar-sweetened fruit beverages, coconut water, barley water, milk, milkshakes without diarrhoea, custards, thin dals, eggs, baked fish, curds, cottage cheese, breakfast cereals, gruels, milk desserts, and vegetable soup

#### **Foods to be avoided**

- Rich pastries, fried dishes, desserts, creamy soups, ghee, vegetable oil, non-irritating fibrous foods, chilies, and other spices
- Because of inflammation in the intestines, extreme caution must be used to avoid any irritant grains and spices from the diet.
- Appropriate nourishment shortens the convalescence timeframe. Refined cereals, bread, eggs, and boiled potatoes can be provided.

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## 8.7. INFLUENZA

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A serious, transient infection, influenza spreads from individual to individual by being directly inhaled. Small droplets holding virus are released while coughing or sneezing and can be inhaled by individuals in good health.

#### **Symptoms**

The incubation phase lasts between 1 and 7 days, or roughly 2 days. The typical onset is abrupt and is accompanied by headaches, a feeling of lassitude, fatigue, trembling, and fever. The patient typically sneezes or has a sore throat, but they also most often have a dry cough. This condition persists for approximately 5 days and is linked to pyrexia. For a period of one to two weeks, the individual might express feelings of laziness and despair. A secondary, slight increase in temperature is possible, but one of the pulmonary problems is more likely if the temperature is high after the fifth day. The most significant and common consequences of influenza are bronchitis and pneumonia.

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## 8.8 MALARIA

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Malaria in humans is caused by four species of the genus *Plasmodium*. *P. falciparum*, *P. ovale*, and *P. vivax*. The female anopheles mosquitoes carry the malarial parasite and bite humans to spread the disease. Malaria that develops after birth or after receiving blood transfusions is induced malaria.

### Symptoms and Signs

Malaria symptoms typically appear in succession during 4-6 hours. A temperature of 41°C or higher, along with the cold phase symptoms of trembling and the hot-phase symptoms of fever and perspiration phase.

Anorexia, mild diarrhoea, nausea, vomiting, cramps in the abdomen, exhaustion, dizziness, headaches, fatigue, pain in the joints, backache, and dry cough are some of the symptoms that are sometimes present along with the fever.

In *vivax*, *ovale*, or *falciparum* malaria exhibit an every-other-day pattern attack whereas *malariae* malaria exhibit an every-third-day (quartan) pattern attack. Typically, splenomegaly emerges after 4 or more days of persistent acute symptoms.

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## 8.9 TUBERCULOSIS

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India's adult population suffers from tuberculosis, which is one of the foremost causes of morbidity and mortality. In India, there are 1,200 tuberculosis deaths each day (2018). Mumbai has the greatest number of such cases due to migrant labourers, congestion in homes and trains, alcoholism, HIV, and unreported events of diabetes. The incidence is widespread among people aged between 25 and 35 years old.

A bacillus called *Mycobacterium tuberculosis* causes the infectious disease tuberculosis. The lungs are the most frequently affected organ, although other organs, including the lymph nodes, gut, meninges, joints, bones, skin, or even the meninges, may also be locally affected or be more widespread. Bacilli remain dormant in the body throughout the duration of the infection. This stage is termed as the latent stage of tuberculosis, and about 40% to 70% of people have been diagnosed with latent tuberculosis. Even after 20 years, if immunity deteriorates, a few people develop tuberculosis. Bacilli that become active, reproduce, and spread illness are said to be growing.

### 8.9.1. CLINICAL FEATURES

The symptoms of pulmonary tuberculosis include tissue wasting, tiredness, cough, expectoration (coughing up respiratory secretions) and fever. The acute phase includes a high fever and is similar to pneumonia. Although the rate of metabolism rises during the chronic phase, it is much lower than it is during the acute phase and is followed by a low-grade temperature. Because of the prolonged sickness, there may be significant wasting. Patient symptoms include a decrease in appetite, discomfort in the chest, exhaustion, loss of weight, night sweats, and a chronic, severe cough as the disease progresses. When the blood vessels in the lungs are damaged, the sputum that the patient coughs up may become stained with blood. As a consequence of this, tubercle bacilli may acquire entry into the blood and travel to different parts of the body.

### 8.9.2. TREATMENT

A combination of the medication's rifampicin, isoniazid, pyrazinamide, and ethambutol is used for the treatment of tuberculosis. Through government-run hospitals and healthcare amenities, these medications are given to patients without charge. The Directly Observed Treatment Short Course (DOTS) is the basis for the Revised National TB Control Programme, which tracks the progress

made. The course of treatment continues for at least nine months.

### **8.9.3. MODIFICATION OF NUTRIENTS**

#### **Energy:**

A healthy bodyweight can be sustained with 2500 to 3000 calories because the body's rate of metabolism is not quite as high as it is during various fevers. It is advised to consume 45–50 kcal/kg of body weight for adults and 90 kcal/kg of body weight for youngsters. Gains of more than 10% beyond the appropriate weight for the body frame are not preferred. Diets high in calories are recommended.

#### **Protein:**

The serum albumin value, particularly in cases with advanced tuberculosis and long-running cases, may be inadequate. It is required to consume protein in tuberculosis significantly more than the usual needs. The recommended daily intake ranges from 80 to 120 g. It is advised that adults can consume 1.5–2 g/kg of body weight and child require about 3–3.5 g/kg of protein.

#### **Minerals:**

The metabolism of vitamin D is interrupted by the medication isoniazid. This can consequently reduce the absorption of calcium and phosphorus. Since calcium is also necessary for the recovery of tuberculosis lesions, it needs to be given in large quantities. Milk intake should be at least one litre per day. When there is a haemorrhage, the demand for iron is likely to be enhanced. Cell, blood, and fluid recuperation are facilitated by minerals such as iron, calcium, and phosphorus.

#### **Vitamins:**

Tuberculosis has negative effects on the metabolism of vitamin A. Carotene cannot be turned into vitamin A, hence vitamin A supplements must be added to the diet or vitamin A rich food such as eggs, liver etc.

Isoniazid, a drug given for the treatment of tuberculosis, is a pyridoxine antimetabolite that blocks the synthesis of pyridoxal phosphate. Transaminases, which are needed for the metabolism of amino acids like glutamic acid, use pyridoxal phosphate as a cofactor. Because glutamic acid is the sole amino acid that the brain can metabolise, a deficiency in pyridoxal phosphate inhibits glutamic acid uptake and triggers the development of neuritis. This effect can be avoided by using high doses of 50–100 mg of pyridoxine daily.

Isoniazid also interacts with vitamin D metabolism. This sequentially restricts the absorption of calcium and phosphorus. Thus, dietary supplementation with vitamins and minerals is essential.

### **8.9.4. DIETARY MANAGEMENT**

Individuals have poor appetites in the beginning; therefore, meals should be tempting, and the individual's preferences should be taken into account.

During the acute phase, a high-calorie fluid diet and a soft diet are advised. Firstly, small volumes of fluid should be provided once every three hours. When the fever drops, the span of time can be raised to four hours.

With the proper treatment individual recovers but become malnourished due to the catabolic activity. Therefore, high calorie and high protein diet can be offered. One litre of milk and 3 to 4 eggs each day are provided.

To meet the needs for micronutrients and antioxidants, two to three servings of various fruits are advised. Normal, appealing, and tempting meals is to be provided when the individual's condition

improves. The person being treated needs to get back to their optimal body weight. The three main components for recovering from tuberculosis were relaxation, oxygen-rich air, and a healthy diet.

#### 8.9.5. PREVENTION

India wants to end TB by 2025. Children who receive the BCG vaccine are protected from TB, but adults are not. The elimination of tuberculosis may be aided by reducing hunger and establishing diagnostic facilities in every district.

Spreading of infection and transmission must be stopped in order to outsmart tuberculosis bacilli. A person's immunity can be developed by proper nutrition, which can help them overcome all of these processes.

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### 8.11 LET US SUM UP

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Fever is a temporary increase in body temperature, often in response to an infection or illness. It is a natural defence mechanism of the body that helps fight off infections by stimulating the immune system. Fever is commonly accompanied by symptoms such as chills, sweating, headache, and body aches. It can be categorized as short-term or chronic, depending on its duration. Short-term fever is typically associated with common illnesses like colds, influenza, and tonsillitis, while chronic fever may be indicative of more serious conditions like tuberculosis or autoimmune disorders. It is important to monitor and manage fever appropriately, seeking medical attention, when necessary, to address the underlying cause and promote recovery.

During a fever, it is important to focus on maintaining hydration and consuming a light, nutritious diet. Drink plenty of fluids, including water, soups, and herbal teas, to stay hydrated. Opt for easily digestible foods like fruits, vegetables, whole grains, lean proteins, and legumes. Include immune-boosting foods such as garlic, ginger, turmeric, citrus fruits, berries, and yogurt. Avoid processed foods, sugary snacks, and fried or greasy foods. Pay attention to any triggering foods that worsen the symptoms. Remember to follow medical treatment and take prescribed medications as directed along with dietary modification.

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### 8.11. CHECK YOUR PROGRESS

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#### Fill in the blanks:

- The infectious disease tuberculosis is caused by .....
- The .....mosquitoes carry the malarial parasite which bites humans to spread the disease.
- .....of lymphatic tissue that are located in the small intestine but predominantly in the ileum are the site of infection in typhoid fever.
- Typhoid occurs by the bacteria.....and paratyphoid B by.....

#### Short answer type question:

1. Mention the foods to be included and excluded in Typhoid?

.....  
.....

2. State the main symptoms of Influenza?

.....  
.....

3. Briefly explain the dietary management of typhoid?

.....  
.....

4. Discuss the Metabolic changes during fever?

.....  
.....

5. Describe the types of fever?

.....  
.....

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## **Unit-9 : NUTRITION IN HEPATIC PROBLEMS**

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### **Structure**

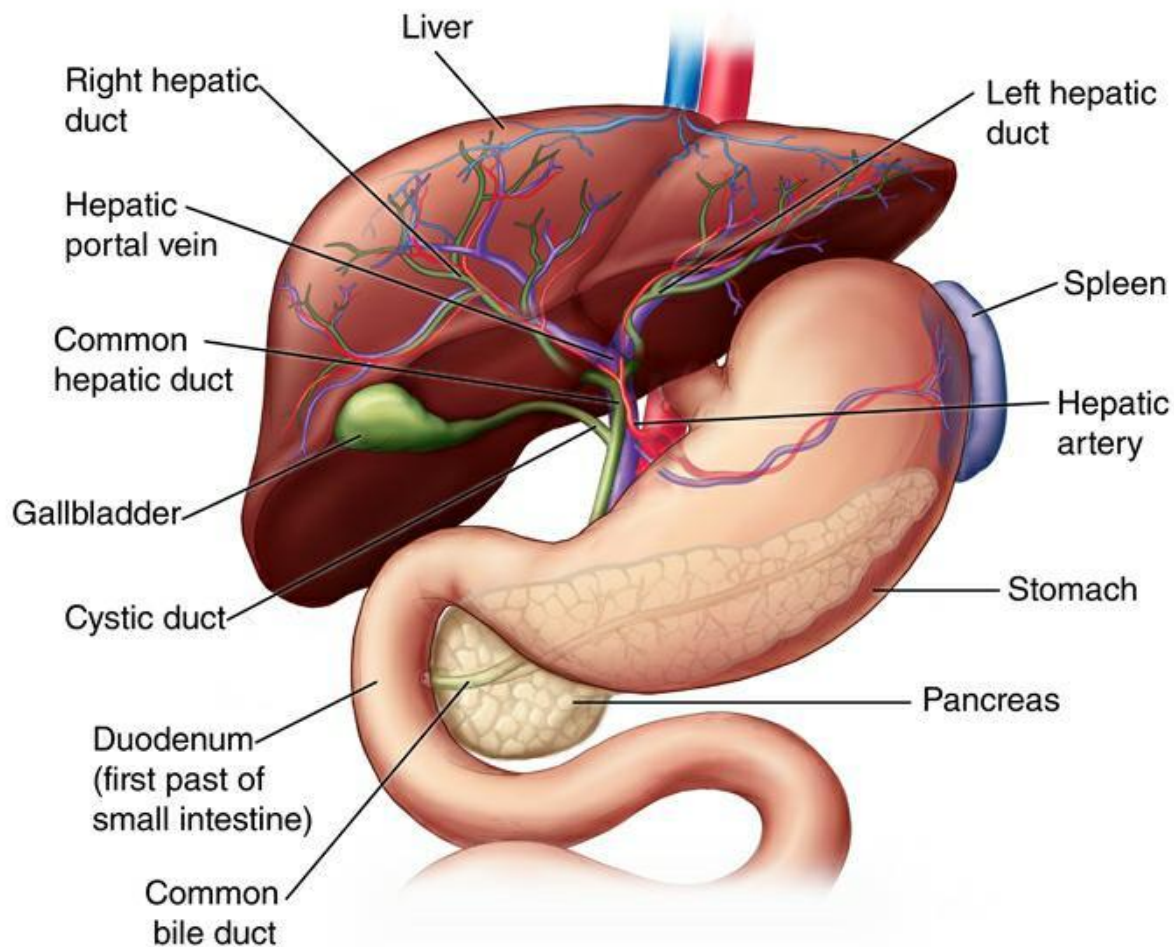
- 9.1 Introduction
- 9.2 Structure of the Liver
- 9.3 Functions of the Liver
- 9.4 Jaundice
  - 9.4.1 Etiology of Jaundice
  - 9.4.2 Symptoms of Jaundice
  - 9.4.3 Diagnosis of Jaundice
  - 9.4.4 Nutritional Management of Jaundice
- 9.5 Hepatitis
  - 9.5.1 Etiology of Hepatitis
  - 9.5.2 Symptoms of Hepatitis
  - 9.5.3 Diagnosis of Hepatitis
  - 9.5.4 Nutritional Management of Hepatitis
- 9.6 Fatty Liver Disease:-
  - 9.6.1 Etiology of Fatty Liver Disease
  - 9.6.2 Symptoms of Fatty Liver Disease
  - 9.6.3 Diagnosis of Fatty Liver Disease
  - 9.6.4 Nutritional Management Of fatty Liver Disease
- 9.7 Liver Cirrhosis
  - 9.7.1 Etiology of Liver Cirrhosis
  - 9.7.2 Symptoms of Liver Cirrhosis
  - 9.7.3 Diagnosis of Liver Cirrhosis
  - 9.7.4 Nutritional Management Of liver Cirrhosis
- 9.8 Hepatic Coma
- 9.9 Let Us Sum Up
- 9.10 Check Your Progress

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### **9.1 INTRODUCTION**

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The liver is a central organ in the human body, essential for numerous physiological processes, including metabolism, detoxification, bile production, nutrient storage, and regulation of energy balance. Hepatic problems, such as acute liver failure, chronic liver diseases (including cirrhosis and non-alcoholic fatty liver disease), and infections like hepatitis, can severely compromise these functions, leading to systemic health challenges. These conditions often result in metabolic disturbances, nutrient deficiencies, and impaired detoxification, which exacerbate the disease and its



symptoms. Nutrition plays a pivotal role in the management of liver diseases, as it directly influences liver metabolism, supports tissue repair, and helps counteract complications such as muscle wasting, fluid retention, and encephalopathy. Tailored dietary interventions not only address nutrient deficiencies but also contribute to slowing disease progression, reducing inflammation, and enhancing overall patient outcomes. This chapter delves into the intricate relationship between nutrition and liver health, highlighting therapeutic strategies to optimize care in individuals with hepatic problems.

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## 9.2 STRUCTURE OF THE LIVER

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The liver is a beautifully designed organ and is located in the upper right side of the abdominal cavity, beneath the diaphragm, and is on top of the stomach, right kidney, and the intestines. The liver is an organ in the human body which is responsible for an array of functions which support major metabolism pathways, immune functions, digestion, detoxification, vitamin storage along with other functions. The liver is shaped like a cone; dark reddish-brown in color that weighs about 3 pounds which is about 1360g in a young healthy adult which comprises 2% of total body weight.

The liver is a uniquely designed organ due to its dual blood supply from the portal vein (approximately 75%) and the hepatic artery (approximately 25%).

There are 2 sources that supply blood to the liver, are as following -

1. Oxygenated blood flows in via the hepatic artery
2. Nutrient-rich blood flows in via the hepatic portal vein.

The liver holds about 560ml (13%) of the body's blood supply. The liver consists of 2 main lobes. Both lobes are made up of 8 segments that consist of 1,000 lobules (small lobes). These lobules are connected to small ducts (tubes) which further connect with larger ducts to form the common hepatic duct connected to the common bile duct. Common hepatic duct transports bile synthesis by the liver cells to gallbladder and duodenum (first part of small intestine) via the common bile duct.

The functional unit of liver is called lobule. Each lobule is hexagonal in shape and a portal triad (portal vein, hepatic artery, bile duct) sits at each corner of hexagon. Foundation of lobules are composed of hepatocytes, that have physiologically distinct apical and basolateral membranes. On the basis of function and perfusion, hepatocytes are divided into 3 zones.

1. **Zone I** -The periportal region of hepatocytes and has the best perfused and very first to regenerate due to high availability of oxygenated blood and nutrients. Because of the high perfusion, zone I plays major role in gluconeogenesis, oxidative metabolisms such as beta-oxidation, bile formation, cholesterol formation, and amino acid catabolism etc.
2. **Zone II** -This zone is defined as pericentral region of the hepatocytes and zone II situated between zones I and III.
3. **Zone III** -Zone 3 has lowest perfusion due to distance from the portal triad. This zone plays the largest role in ketogenesis, detoxification, glycolysis, biotransformation of drugs, glutamine formation, lipogenesis, glycogen synthesis etc.

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### 9.3 FUNCTIONS OF THE LIVER

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The liver plays very vital role in nearly every organ system of the human body. Liver interacts with endocrine and gastrointestinal systems by supporting in digestion and metabolism. Liver is warehouse location of fat-soluble vitamins and handles cholesterol homeostasis along with storing iron and copper. Liver plays role in hematology by adding clotting factor and protein synthesis. It plays a role in heme breakdown into bilirubin and conjugates it. Liver plays a role in sex hormone metabolism and produces carrier proteins that are important in reproduction and development. Lastly but not least, the Kupffer cells and Pit cells play an important role in body's immunologic responses.

In this unique way liver plays more than 500 important functions in human body.

**Bile Production:** Bile is an important fluid in human body, it helps excrete waste which is not excreted by the kidneys and aids in digestion and absorption of fats and lipids via secretion of bile salts and acids. Bile is produced by hepatocytes which mainly consist of water, electrolytes, cholesterol bile salts, bile acids, pigments, bilirubin, phospholipids and in addition to other substances. Bile is ending up in the duodenum and being stored in the gallbladder. Bile performs its functions in bowel, and bile components which are not excreted are recycled as conversion into bile acids by gut bacteria for reuse by absorption in the ileum and transport back to the liver.

**Fat-Soluble Vitamin Storage and/or Metabolism:** Fat-soluble vitamins reach to the liver by intestinal absorption in the form of chylomicrons or very low density lipoproteins (VLDL). Liver stores and if required metabolizes fat-soluble vitamins. Even vitamin D3 comes from the skin, fortified foods like animal products and plant products, this must undergo 25-hydroxylation by the hepatic CYP-450 system. Liver receives vitamin E in its alpha and gamma-tocopherol forms. Alpha-

tocopherol is integrated with very low density lipoproteins/high density lipoproteins in liver and then secreted back into circulation. Vitamin K is not stored or metabolized in liver, but presence of vitamin K is essential as liver enzyme i.e. gamma-glutamyl carboxylase requires it for gamma-carboxylation for coagulation factors like II, VII, IX, X, protein C and protein S.

**Drug Metabolism:** Liver performs a very critical function of metabolism and detoxification of drugs by using lysosomes. As major route of metabolism and detoxification is through biotransformation. These reactions take place mainly in smooth endoplasmic reticulum of hepatocytes. Other organs like kidney and gut also help in drug metabolism but liver is major organ to work on detoxification of drugs.

**Bilirubin Metabolism:** Liver plays a very significant role in breakdown of heme. Hemolysis takes place at multiple sites throughout body, like in liver, spleen, and bone marrows. Liver receives unconjugated bilirubin bound to albumin from the circulation. Liver works on unconjugated bilirubin; the newly conjugated bilirubin is secreted through bile canaliculi into bile or small amounts dissolve in blood here it gets filtered for excretion by kidneys. Major conjugated bilirubin enters in bile and is excreted with bile through feces as conjugated bilirubin which is not absorbed by the intestine.

**Other Major Functions:** As liver plays more than 500 functions in human body, some major functions are -

- Liver plays a role in thyroid hormone function as the site of deiodination of T<sub>4</sub> to T<sub>3</sub>.
- Liver manages to synthesize nearly all the plasma protein in the body, some are named as albumin, binding globulins, protein C, protein S, all the clotting factors of the intrinsic and extrinsic pathways.
- Cholesterol and special proteins synthesis help carry fats throughout the body.
- Liver converts excess glucose into glycogen for storage (glycogen later can be converted back to glucose for energy) and balance it to make glucose available when needed by body.
- Liver regulates blood levels of amino acids, which forms the building blocks of proteins.
- Liver converts ammonia to urea (as urea is end product of protein metabolism and is excreted in urine).

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## 9.4 JAUNDICE

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Jaundice is a very common condition that affects infants, children, and adults. Jaundice is the term used to define the state of body where yellowing of the skin and whites of the eyes occurs. Jaundice may occur when blood contains an excess of the pigment called bilirubin, a natural product arising from normal breakdown of red blood cells (RBCs) in body and excreted through bile by the liver.

As bilirubin gets generated in our body, the liver functions in maintaining the level of bilirubin in the body.

Red Blood Cells (RBCs) is a blood component that carries oxygen to various parts of the human body. RBCs are expected a lifespan of 3 to 4 months. After reaching their lifespan, RBCs are broken down and removed from circulation by special cells called phagocytes. RBC on breaking down may get separated into amino acids, iron, and bilirubin, out of these amino acids and iron are useful to body, whereas bilirubin needs to be excreted out from the body.

Waste products from body get excreted either through the kidney in the form of urine or through the liver in form of bile. When bilirubin is formed from RBC breakdown, it passes through blood to

liver, where bilirubin gets converted into bile juice. Bile juice comes out of liver and then joins first part of the small intestine. It then passes through small and large intestine and gets expelled out with stool. Due to the disturbance in this process, amount of bilirubin inside body can increase and turn the skin color to yellow known as jaundice.

#### **9.4.1 ETIOLOGY OF JAUNDICE**

The inability of body to expel out the bilirubin leads to jaundice. There are several causes which suddenly or over the time period makes the bilirubin to pile up inside body. The main causes of Jaundice are:

- Higher rate of RBC breakdown resulting from prevailing health issues, such as infections like malaria, sickle cell anemia, Gilbert syndrome etc.
- Viral infections of the liver and from prolonged exposure to harmful substance, such as alcohol and drugs.
- Obstructive jaundice is resulting due to an interruption in drainage of bile in biliary system. This could be due to pancreatic malfunction or the presence of a gallstone in the common bile duct.
- Pancreatitis could be a cause also.

#### **9.4.2 SYMPTOMS OF JAUNDICE**

Common symptoms which a patient suffering from jaundice experiences is:

- Yellow discoloration of the eyes, skin and gums
- Fever, chills
- Abdominal pain
- Flu-like symptoms
- Dark colored urine.
- Pale colored stool.
- General fatigue.
- Loss of appetite
- Weight loss.



### 9.4.3 DIAGNOSIS OF JAUNDICE

Provisional Diagnosis can be made as the onset of jaundice from primary symptoms exhibited by patient. The patients have to undergo certain laboratory tests like -

1. **Blood Test-** Blood tests help to check the level of bilirubin in blood. Bilirubin levels above the acceptable norms are an indication of jaundice.
2. **Urine Test-** Urine test helps in identifying the level of urobilinogen. In the digestive system, as bacteria break down bilirubin, this leads to production of urobilinogen.

### 9.4.4 NUTRITIONAL MANAGEMENT OF JAUNDICE

Nutritional management plays a very crucial role in the treatment of jaundice and even post jaundice rehabilitation. Improving health of the liver is prime aim here.

**Nutritional assessment:** Nutritional assessment is a systematic process of collecting and understanding then interpreting information in order to make decisions about nature and cause of nutrition related health issues that affect an individual and disease related outcome (British Dietetic Association, BDA).

Assessment such as height or weight, as well as the fat mass composition of the human body to provide information about a person's nutritional status.

Objectives:

- To know the significance of nutritional assessment.
- Identify factors which affect nutritional status of individuals.
- Identify challenges in nutritional assessment.
- Summarize the role of nutritional assessment in relation to disease.

Easy way to remember types of nutrition assessment is ABCD:

**A for Anthropometric:** Some of common anthropometric measurements includes height, weight, body mass index (BMI), waist-to-hip ratio (WHR), head circumference skinfold measurements etc.

**B for Biochemical:** Biochemical or laboratory methods for assessment of nutrient and its metabolites in blood, faces, urine and other tissues that have a relationship with the nutrient. Example is measuring blood glucose level in diabetes patients.

**C for clinical:** Clinical methods of nutritional assessment involve checking signs of deficiency at specific places on the body like skin, hair, tongue, lips etc or asking patient whether they have any symptoms that might suggest nutrient deficiency. For example, bleeding gums in case of vitamin C deficiency and muscle loss in protein deficiency.

**D for dietary:** Anthropometry is measurement of the size, weight, and proportions of the body and finding BMI and WHR etc according to height and age.

**Subjective global Assessment(SGA) proforma** can be used to assess nutritional status as this type of SGA is globally accepted. Refer the given proforma for example –

|               |             |       |
|---------------|-------------|-------|
| Patient Name: | Patient ID: | Date: |
|---------------|-------------|-------|

  
**Part 1: Medical History**

**1. Weight Change**

|    |                                                                                |                                                    |  |
|----|--------------------------------------------------------------------------------|----------------------------------------------------|--|
| A. | Overall change in past 6 months:                                               | kgs.                                               |  |
| B. | Percent change: _____<br>gain - _____ 5-<br>10% loss _____ ><br>10% loss _____ | < 5% loss<br><br>increase<br>no change<br>decrease |  |
| C. | Change in past 2 weeks:<br>_____<br>_____<br>_____                             |                                                    |  |

**2. Dietary Intake**

|    |                                                                                 |                                |
|----|---------------------------------------------------------------------------------|--------------------------------|
| A. | Overall change: _____ no change<br>_____ change                                 |                                |
| B. | Duration: _____ weeks                                                           |                                |
| C. | Type of change:<br>_____ suboptimal solid diet<br>_____ hypocaloric liquid diet | full liquid diet<br>starvation |

**3. Gastrointestinal Symptoms (persisting for >2 weeks)**

|            |              |                |                |                |
|------------|--------------|----------------|----------------|----------------|
| _____ none | _____ nausea | diarrhea _____ | vomiting _____ | anorexia _____ |
|------------|--------------|----------------|----------------|----------------|

**4. Functional Impairment (nutritionally related)**

|    |                         |                                                      |
|----|-------------------------|------------------------------------------------------|
| A. | Overall impairment:     | _____ none<br>_____ moderate<br>_____ severe         |
| B. | Change in past 2 weeks: | _____ improved<br>_____ no change<br>_____ regressed |

  
**Part 2: Physical Examination**

**5. Evidence of:**      Loss of subcutaneous fat  
                              Muscle wasting  
                              Edema  
                              Ascites (hemo only)

  
**Part 3: SGA Rating (check one)**

|                   |                                   |                          |
|-------------------|-----------------------------------|--------------------------|
| A. Well-Nourished | B. Mildly-Moderately Malnourished | C. Severely Malnourished |
|-------------------|-----------------------------------|--------------------------|

Diet for jaundice may vary depending on severity of jaundice and the underlying medical conditions. At a glance the ideal diet one needs to follow during jaundice treatment and rehabilitation can be fallowed as- The foods and drinks to consume by patients having jaundice includes:

**Water – Fluids:** One of the very important ways to recover from jaundice is to stay well hydrated. Water helps in quick digestion and helps in flushing out bilirubin from the kidney and liver. It is recommended to drink at least 3 litres of water or more per day. People find the taste of water to be bland. In this case, they can add a teaspoon of fresh lemon, lime or mint juice to water. This provides in an extra dose of antioxidants.

**Fruits and vegetables:** Fresh fruits and seasonal vegetables also support liver because as these contain fibre and powerful antioxidants. Fruits and vegetables also help indigestion. They also contain liver-friendly nutrients. leafy green vegetables are ideal for jaundice patients, starchy vegetables, such as potatoes, beets and pumpkins, etc. Legumes, such as beans, peas, lentils, etc. fresh fruits, such as oranges, lemon (citrus fruits), banana, apples, pears and peaches, etc.

**Eat Meat and Fish:** Poultry such as lean chicken, egg whites are good for the patients

rehabilitating from jaundice. fish are also good for patients suffering from jaundice. Avoid red meat and preparations during the peak jaundice.

**Dairy Products:** Low fat milk are ideal for jaundice patients. Curd and paneer are also preferred milk products of low fat for better digestion and tolerance.

**Drink Beverages:** Jaundice patients need to keep themselves well hydrated. Make sure that you have more than 10 to 12 glasses of water. Unsweetened juices, plain water, green tea, or black coffee are ideal beverages that can be consumed. Make sure to avoid coffee or caffeine-based items more than 2 servings per day.

**Avoid Alcohol:** Patients need to completely avoid alcohol with jaundice and other liver-related problems.

Nutritional management becomes more important in jaundice than any other disease. A balanced and high protein diet helps in the early recovery and better prognosis of liver and its associated functions.

| <i><b>Foods to be Included in Diet</b></i>                                                                                                                                                                                                                                                                                                                                                                                    | <i><b>Foods to be Taken in Moderate Amounts</b></i>                                                                                                                                                                                                                                                                                                     | <i><b>Foods to be Avoided</b></i>                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>-Daily include 10-12 glasses of water every day.</li> <li>-Fresh fruits and vegetables need to be consumed.</li> <li>-Include melons and fenugreek seeds.</li> <li>Include boiled egg whites.</li> <li>-Can include dals, rice and millets which are good in jaundice.</li> <li>-Can include freshly made fruit juice.</li> <li>-Include low fat milk, curd and buttermilk.</li> </ul> | <ul style="list-style-type: none"> <li>-Multigrain whole flour products like bread, pasta, noodles.</li> <li>-Soyabean and products like soyabean milk and paneer.</li> <li>-Green leafy vegetables, radish, brinjal, beans, capsicum and beetroot</li> <li>-Mangoes</li> <li>-Lean chicken and fish</li> <li>-Almonds and walnuts in limit.</li> </ul> | <ul style="list-style-type: none"> <li>-Avoid red meat.</li> <li>-Avoid full fat milk and products.</li> <li>-Avoid deep fried foods and spicy foods</li> <li>-Avoid too much sweets and desserts.</li> <li>-Avoid too much coffee, tea which can cause more inflammation.</li> <li>-Avoid alcohol.</li> <li>-Avoid refined sugar.</li> </ul> |

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## 9.5 HEPATITIS

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Hepatitis is usually an inflammation of liver. Inflammation is swelling of hepatocellulars that happens when tissues of liver are injured or infected. Swelling is known as hepatitis which damages the functioning of liver. Variety of viral infections leads to hepatitis and liver damage. Hepatitis viruses A, E is a major cause of acute hepatitis which may not result in chronic hepatitis, though hepatitis E can lead to fulminant hepatitis in pregnant women.

### **9.5.1 ETIOLOGY OF HEPATITIS**

Hepatitis A and E can be seen in travelers because of consumption of contaminated water or seafood sources. These two types of hepatitis are usually self-limiting illnesses with the symptoms of jaundice and vomiting.

Whereas hepatitis B, C, and D are viruses that cause acute hepatitis that can result in chronic hepatitis. Hepatitis D relies on hepatitis B as reproduction. Hepatitis D can either occur at the same time as hepatitis B, which is called co-infection, or at some time top of hepatitis B, called superinfection which is very dangerous so timely diagnosis is must.

Hepatitis B and C can occur from contaminated needles, from pregnant mother to foetus, in tattooing, intravenous drug use, and Hepatitis B is a sexually transmitted disease.

- Alcoholic hepatitis is caused by chronic alcohol uses.
- Toxic hepatitis - caused by certain poisons, chemicals, medicines and even by supplements also.
- Autoimmune hepatitis- is a chronic type of hepatitis where body's immune system attacks liver.

The treatment against hepatitis A, B, and C is vaccination.

### **9.5.2 SYMPTOMS OF HEPATITIS**

Hepatitis can be acute or chronic infection but some type of hepatitis can cause only acute infections. Many people with hepatitis do not have major symptoms so they do not know why they are infected, symptoms include:

- Fever
- Fatigue
- Joint pain
- Loss of appetite and weight loss
- Nausea and vomiting
- Jaundice – yellow colour eyes and skin
- Abdominal pain
- Dark colour urine
- Clay colour bowel movements

In acute infection, symptoms can start anywhere between 2 weeks to 6 months after infection. In chronic infection, person may not have symptoms until years later.

### **9.5.3 DIAGNOSIS OF HEPATITIS**

**To diagnose of hepatitis, physician or gastroenterologist will take detailed history**

- May ask about symptoms and medical history
- Will do a physical examination
- Likely perform blood tests, including tests for viral hepatitis
- Lately ultrasound and CT scan or MRI can be performed for final diagnosis.
- Some times need to do a liver biopsy to get clear diagnosis and to check for liver damage.

- The IgG is a marker that shows vaccination or prior exposure, whereas IgM shows acute infection. There have been advancements in the treatment of hepatitis C.

#### 9.5.4 NUTRITIONAL MANAGEMENT OF HEPATITIS

Treatment for hepatitis depends on type and whether it is acute or chronic. Person with hepatitis may just need to take rest and get enough fluids. But in some cases, it may be more serious so may need to get hospitalized.

People with alcoholic hepatitis need to stop alcohol consumption along with nutritional management. Impairment of liver function due to hepatitis causes malnutrition, as liver is one of the most important organs involved in metabolism, digestion, absorption and overall nutritional homeostasis. So nutritional support can restore impaired liver function and improve prognosis in patients with hepatitis.

Principles of Nutritional Management are as follows

1. Firstly, maintain the body weight and then achieve the ideal body weight (in case of weight loss).
2. Provide adequate calories and high protein intake of high biological value for liver support and synthesis of important body proteins.
3. Moderate fats and lipids for energy and to support metabolic processes.
4. Adequate vitamins and minerals
5. Fibre and adequate fluids.

#### Nutritional Recommendations for Hepatitis:

Energy: 30-35kcal/kg body weight (upto 40kcal/kg body wt can be given).

Protein: 1.0-1.2g/kg body weight (if protein tolerance is good then 1.5g/kg body weight can be allowed).

Carbohydrates: 55-60% of total energy

Fat: upto 15% of total energy

B-complex, vitamin C and vitamin E and vitamin K and zinc is required while planning a diet for hepatitis patients.

Adequate fluids.

Progress after tolerance to small and frequent feedings.

Hepatitis diet choices are not limited to few bland dishes and foods. There are plenty of healthy choices, tasty food options which are nutritious for the liver and for the recovery process too.

- Whole grains are very beneficial to consume as part of a healthy hepatitis diet. These can be in the form of bran, whole wheat bread or cereal, brown rice, whole grain pasta or porridge. Include other whole grains such as whole oats, wild rice, rye, oatmeal and corn.
- Fruits and vegetables should be a significant part of any diet to help in recovering from a liver disease. They are full of essential nutrients and are easy to digest. As a bonus, they also contain antioxidants, which can protect the liver cells from damage. However, it is recommended that one go easy on starchy vegetables such as potatoes when on a Hepatitis recovery diet. While canned or frozen fruits are fine, it is always a good idea to try and eat fresh and seasonal produce whenever possible.

- Olive oil, canola oil and flaxseed oil are all healthy fats that are recommended as part of a diet for patients with hepatitis.
- Healthy proteins in the form of low-fat milk and dairy product along with lean meats, beans, eggs and soy products can also be a part of a healthy liver diet.

**Refer below for Quick tips -**

- Stay hydrated- water, coffee, or butter milk can support hydration and liver function.
- Eat a variety of fresh fruits and seasonal vegetables every day.
- Look for high fiber foods, like oatmeal, whole grains, cucumber, broccoli, chickpeas, lentiles, berries, and mix nuts.
- Eat variety of proteins of high biological value and choose lean cut meat of animals.
- Maintain ideal body weight.
- Avoid alcohol.

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## 9.6 FATTY LIVER DISEASE

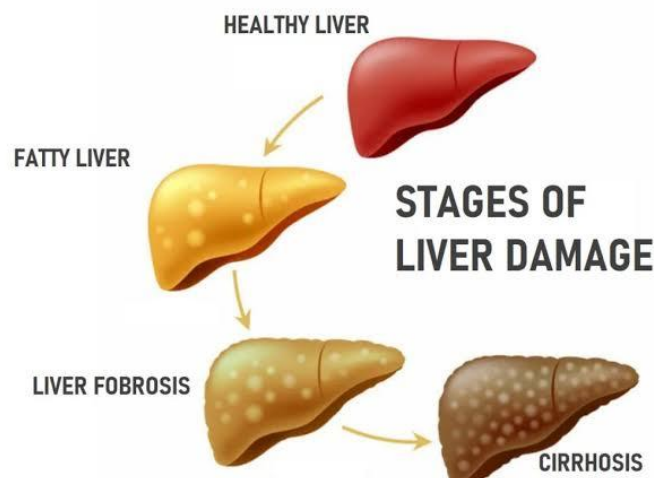
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Fatty liver is defined as a condition where more than 5% fat inside liver affects functioning of liver and causes liver injury. Person who drinks too much alcohol may also have fat inside liver, but that condition is different from fatty liver disease. But one can get fatty liver disease who even don't drink a lot of alcohol.

**Types of fatty liver disease:**

Clinically fatty liver disease can be divided into two types.

1. If a person with just fat more than normal but no damage to liver, the disease is called nonalcoholic fatty liver disease (NAFLD).
2. If person with fat in liver plus signs of inflammation and damage to liver cells the disease is called nonalcoholic steatohepatitis (NASH).



**Image for reference of stage and progression of liver disease.**

### 9.6.1 ETIOLOGY OF FATTY LIVER DISEASE

**When it is alcoholic liver disease, the cause is too much alcohol and other causes are -**

- High BMI or being over weight.
- Protein calorie malnutrition
- Chronic viral hepatitis
- Genes that are more likely to get it - genetics
- Age – 35 year or more are more likely to get fatty liver.
- Large waist size
- High cholesterol
- Low levels of HDL (good) cholesterol
- High blood pressure
- High blood sugar levels etc.

### 9.6.2 SYMPTOMS OF FATTY LIVER DISEASE

Liver disease sometimes is called silent liver disease. As it can happen without causing any symptoms. Most people with NAFLD live with fat in liver without developing any liver damage. Few people who have fat in their liver develop NASH – non alcoholic steatohepatitis. If one has steatohepatitis may have symptoms that could take years for them to develop. If liver damage from NASH leads to permanent scarring and hardening of liver, this is called cirrhosis.

Symptoms from NASH may include:

- Tiredness, fatigue
- Weakness
- Weight loss
- Yellowing of the skin or eyes
- Spiderlike blood vessels on the skin
- Itching all over body.

NASH that turns into cirrhosis could cause symptoms like fluid retention, internal bleeding, muscle wasting, and confusion. People with cirrhosis over time may develop liver failure and need a liver transplant.

### 9.6.3 DIAGNOSIS OF FATTY LIVER DISEASE

Information can help doctors to diagnose non alcoholic fatty liver disease.

1. **Physical examination:** – Body weight, waist circumference for signs of liver problems such as enlarged liver or jaundice.
2. **Blood tests:** These can show if one has high levels of liver enzymes such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST). If so, there could be a problem with your liver.

3. **Ultrasound:** Studies on liver may show fat deposits. Some imaging tests like fibro scan and MRI scans can help diagnose the disease and spot scar tissue in the liver. The only way to confirm that fatty liver disease is the only cause of liver damage is through liver biopsy and histopathological study.

#### 9.6.4 NUTRITIONAL MANAGEMENT OF FATTY LIVER DISEASE

Principles of Nutritional Management are as follows

1. To reduce the body weight and then maintain the ideal body weight (in case of over weight and obese).
2. Provide low calories and high protein of high biological value to preserve lean muscle mass.
3. Restrict carbohydrates and simple sugars to cut on total calories.
4. Low fats and lipids for energy and to support metabolic processes.
5. Adequate vitamins and minerals
6. High fibre and adequate fluids.

#### Nutritional Recommendations for NAFLD:

- Energy: 20-25kcal/kg body weight.
- Protein: 1.0-1.2g/kg body weight
- Carbohydrates: 50-55% of total energy
- Fat: up to 15% of total energy
- B complex, vitamin C and vitamin E and vitamin K and zinc is required while planning a diet for NAFLD patients.
- Adequate fluids.
- High fibre, small frequent meals and in between free foods for satiety.

#### Lifestyle changes:

- **Eat healthy food-** Choose a plant-based diet with lots of fruits, vegetables, whole grains and healthy fats in moderation.
- **Stay at healthy weight-** Lose weight if over weight. If weight is ideal, work to maintain it by choosing a healthy diet and exercising.
- **Exercise-Make physical activity a regular habit.** Try to be active at least 30 minutes a day most days of the week. Try losing weight if over weight.
- **Be kind to liver -** Avoid alcohol, take advised medications and over-the-counter drugs only as instructed by physician.
- **Reduce cholesterol level-** A plant-based diet, exercise, and medications helps in keeping cholesterol and triglyceride levels where they need to be.
- **Manage blood sugars or insulin resistance – Simple Carbohydrate restrictions along with physical activity** and take medications prescribed by doctor.

Refer below the food list advised for NAFLD (Nonalcoholic fatty liver disease)

| <u>What foods should you eat</u> | <u>What foods should you not eat</u> |
|----------------------------------|--------------------------------------|
|----------------------------------|--------------------------------------|

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Expert recommends the Mediterranean diet to individuals with fatty liver disease.</li> <li>• The Mediterranean diet emphasizes on high intake of vegetables, fruits, and healthy fats.</li> <li>• Liver-friendly diet includes whole grains, nuts, and legumes.</li> <li>• Lean meats should be consumed in moderation and red meats should be totally avoided.</li> <li>• Sweets and added sugars should be limited.</li> </ul> | <ul style="list-style-type: none"> <li>• Sugary beverages like soda, juice, lemonade, and sports drinks should be avoided.</li> <li>• Red meats, bacon, and other processed meats should be limited in the diet.</li> <li>• Butter should also be limited, and foods containing trans fats like fried foods, such as french fries, fried chicken, and doughnuts, processed snacks, such as crackers and chips and baked goods, such as cakes, cookies, and pastries should be avoided completely.</li> </ul> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### **Tips to the NADLD/Fatty Liver Diet**

1. Focus on whole grains, plant-based diet: Include 5-7 servings of vegetables, fruits and 7-8 servings of whole grains, 1 serving of nuts, and 2 serving of legumes in daily diet. Such combination foods are rich in fibre, vitamins, and minerals, and low in saturated and trans fats, which can be beneficial for individuals with fatty liver disease.
2. Limit processed foods, such as fast food, snacks, and bakery products, often contain high amounts of sugar, unhealthy fats, and additives that can worsen the grade of fatty liver disease. Junk food contains high levels of fructose, trans and saturated fats and high fructose corn syrup, which increases the amount of fats.
3. Choose lean protein: Choose lean protein sources such as low-fat paneer, curd, skinless poultry, fish, beans, and lentils over red meats.
4. Avoid sugar and Products - Sugary beverages like soda, juice, lemonade, and sports drinks and other sugary and carbonated beverages contain high amounts of fructose and other sugars. When these kinds of sugars are taken in high amounts they are processed in liver and converted into fat, leading to the accumulation of fat in liver cells. So, it's better to opt for water, buttermilk, unsweetened tea, or coffee.

Check portion sizes: Overeating leads to weight gain and increases risk of fatty liver disease. Be mindful for portion sizes and consider using smaller plates and bowls to help control portions. Large portion sizes contribute to weight gain and obesity, which are risk factors for fatty liver disease. When one eats more calories than our body needs, the excess calories suppose to be stored as fat in liver and other sites of body, leading to the development of fatty liver disease.

5. Stop or Limit alcohol consumption: Drinking alcohol in excess damages the liver and exacerbates fatty liver disease. If one chooses to drink, do so in moderation that too on occasionally. Complete abstinence from alcohol, especially for those with alcoholic fatty liver disease is a way to reverse NAFLD.
6. Exercise: Regular physical activity 30 minutes a day or 150 minutes per week is essential and can aid in weight loss, improves insulin sensitivity, a decreased risk of fatty liver disease.

**Important Note** – Counselling for a simple lifestyle change can help a long way in preventing

and even reversing NAFLD/ fatty liver disease.

### **Sample meal plan For Fatty Liver**

**Morning**—1 glass Luke warm water (with or without lemon)

30–45minute brisk walk/cycling/swimming/jogging etc.

1 cup tea (skimmed milk and no sugar).

#### **Breakfast:**

1. 2-Besanchilla made with gram flour, onion, tomato, capsicum, green chutney/2Chapati + 1bowl vegetables/ 1 bowl dalia/ 1bowl upma/poha

2.150ml curd/milk (skimmed milk)

3. 2 egg whites (boiled)/50 gm panner (fat free)

#### **Mid Morning:**

11.30am- Buttermilk 150-200ml+ a handful of mixed nuts.

#### **Lunch:**

2 chapatis + ½ bowl rice

1bowl -Dal (thick)

1 bowl vegetables

1 bowl curd (fat free 150ml -raita)

1 plate salad

#### **Evening:**

4.30-5.00pm – Roasted Chana 40gm/makhana (fox nuts)+ green tea/100ml butter milk.

#### **Dinner:**

1-2 chapati + roasted vegetables and dal.

#### **Bed Time:**

150-200 ml milk.

**Important Note** -All requirement needs to be calculated on the basis of individual's weight, height, age, sex and lifestyle type i.e. sedentary, moderate etc. Then distribute the macro and micro nutrients accordingly and choose portion size as per requirement and follow recommendations of ICMR (Indian Counsel of Medical Research) and calculate RDA(Recommended dietary allowances).

Flexibility and exchange list need to be considered while planning diet for any disease patients.

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## **9.7 LIVER CIRRHOSIS**

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Cirrhosis is a progressive clinical condition when scar tissues gradually replace healthy liver cells. Cirrhosis is final stage due to various chronic liver diseases after years may be decades of slow progression. There are effective ways to prevent cirrhosis, because several measures are available to prevent and treat this condition.

### **9.7.1 ETIOLOGY OF LIVER CIRRHOSIS**

Underlying disease may be chronic hepatitis B and C, other chronic viral hepatitis, fatty liver disease due to any of the very common underlying disorders i.e. obesity, diabetes and chronic alcohol abuse

which commonly progresses to cirrhosis if untreated.

**Common causes of cirrhosis are: -**

- Hepatitis and other viruses
- Alcohol abuse for long time
- Nonalcoholic fatty liver disease /NAFLD (this is associated with metabolic syndrome such as obesity, high cholesterol, triglycerides and high blood pressure etc)

**Other less common causes of cirrhosis may include:**

- Autoimmune disorders.
- Use of certain medicines and toxins.
- Exposure to certain toxic chemicals.
- Parasite infections.

### **9.7.2 SYMPTOMS OF LIVER CIRRHOSIS**

Symptoms may vary, depending on how severe cirrhosis is as mild cirrhosis may or may not cause any symptoms at all.

**What are the symptoms of cirrhosis?**

Symptoms may vary, depending on how severe cirrhosis is. Mild cirrhosis may not cause any symptoms at all.

Symptoms may include:

- Muscle loss
- Loss of appetite
- Itching
- Yellowing of the skin and eyes (jaundice)
- Vomiting blood from bleeding blood vessels in food pipe (esophagus)
- Easy bruising
- Spider-like veins in the skin
- Low energy and weakness (fatigue)
- Weight loss
- Fluid buildup in belly (ascites)
- Confusion as toxins build up in the blood (hepatic coma)

### **9.7.3. DIAGNOSIS OF LIVER CIRRHOSIS**

1. Blood tests: -There are several numbers of liver function tests to see if the liver is working the way it should be.

2. Ultrasound: This imaging test scans internal organs as how they are working. For this test machine uses high-frequency sound waves and a computer to create images of organs and related blood supply system around.

3. Liver biopsy: Small tissue samples can be taken from liver with a needle or during surgery. Then

the samples are checked under microscope to find out type of liver disease.

4. CT scan (computed tomography). This imaging test uses X-rays and a computer to create data on bones, muscles, fat, and organs.

5. MRI (magnetic resonance imaging). Through this test detailed picture of organs and structures inside the body is studied. For MRI imaging magnetic field and pulses of radio wave energy is used.

6. Endoscopy (EGD). Lighted flexible camera is placed through mouth into upper digestive tract to check for enlarged blood vessels if those are at risk of bleeding because of cirrhosis.

#### **9.7.4 NUTRITIONAL MANAGEMENT OF LIVER CIRRHOSIS**

Principles of Nutritional Management are as follows

1. Maintain the ideal body weight (in case of weight loss and or muscle loss)
2. Adviced for high calorie and high protein of high biological value to ensure adequate calorie and protein to preserve lean muscle mass.
3. Adviced for high carbohydrates diet for instant energy (carbohydrate to be chosen sensibly if patient is suffering from cirrhosis along with diabetes).
4. Moderate fats and lipids for energy and to spare protein for body building and amino acid synthesis.
5. Adequate vitamins and minerals (sodium restricted diet if ascites is present)
6. High fibre and adequate fluids.
7. Small and frequent meals.

#### **Nutritional Recommendations for Liver Cirrhosis:**

- Energy: - 30-35kcal/kg body weight (upto 40 kcal can be adviced if tolerating)
- Protein: - 1.0-1.2g/kg body weight (upto 1.5g/kg body weight if tolerating)
- Carbohydrates: - 55-60% of total energy
- Fat: - upto 15% of total energy from good quality fat MUFA and PUFA.
- B complex vitamins, vitamin C, vitamin E, vitamin K and zinc is need to be considered while planning a diet for hepatitis patient.
- Adequate fluids (restrict fluids and sodium after discussion with treating consultant).
- High fibre small, frequent meals in between free foods for satiety.

#### **Sample meal plan for Cirrhosis patients**

##### **Morning:**

1 glass lukewarm water (with or without lemon)

1 cup tea/coffee/lassi/milk shakes (use at least 200ml milk)

##### **Breakfast:**

1. 3-Besan chilla made with gram flour, onion, tomato, capsicum + green chutney/3

Chapati + 1 bowl vegetables/ 2 bowl dalia/ 2 bowl upma/poha

2. 200ml curd/milk (tonned condensed milk)

3. 3-4 egg whites (boiled)/ 80 gm panner (appropriate Protein supplements can be taken)

**Mid Morning:**

11.30am – 50gm channasattu/dal halwa/home made protein bar+ small seasonal fruit

**Lunch:**

3-4 Chapati + ½ bowl rice

1bowl -Dal (thick)

1 bowl vegetables

1bowl curd (fat free 150ml / 50gm panner)

Salad+lemon

**Evening:**

4.30-5.00pm – Roasted Channa 50gm/ sattulassi/2egg omelette+ tea/coffee (with added milk)

**Dinner:**

3chapati + vegetables and dal (thick)/chicken /fish curry

**Bed time:**

Milk (condensed) + Dry fruit powder/Protein supplement.

**Important Note** -All requirement needs to be calculated on the basis of individual's severity of disease, weight, height, age, sex and lifestyle type i.e. sedentary, moderate etc. Then distribute the macro and micro nutrients accordingly and choose portion size as per the requirement and recommendations of ICMR (Indian council of medical research), RDA (Recommended Dietary Allowances).

Flexibility and exchange list need to be considered while planning diet for any disease patients.

As cirrhosis is a progressive disease that happens over time. The damage to liver can sometimes reverse or improve if one stops drinking alcohol or if the virus is completely treated.

The nutritional goal is to support medical treatment and slow down the buildup of scar tissue, prevent or treat other related issues.

In many cases, patient may be able to delay or stop any more liver damage.

**Tips to follow for healthy liver**

1. Follow a healthy lifestyle.
2. Eating a healthy high protein diet, low in sodium.
3. Not having alcohol or self medication
4. Consulting doctor on time regarding any health problems that happened because of cirrhosis.
5. Consult to healthcare provider before taking medicines, over-the-counter medicines, or vitamins.

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## 9.8 HEPATIC COMA

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Liver synthesizes most of body proteins by amino acids absorbed from the digestive system. Protein degradation generates free amino acids, which may be transaminated and deaminated that produces ammonia. Ammonia is a toxic metabolite which is effectively removed from the circulation via

hepatic conversion to urea, which is then eliminated in urine by kidneys. But when liver function is impaired, hyperammonemia occurs which increases the chances of developing hepatic encephalopathy.

As Ammonia is generated from protein breakdown still clinical studies suggests Vegetable proteins are best tolerated, followed by proteins contained in dairy foods, milk and curd. Vegetables protein sources are thought to be beneficial because of high fibre content as fibre promotes bacterial fermentation and decreases colonic transit time that decreases ammonia absorption from gut, but also because of their high branched chain amino acid content.

European Society of Parenteral and Enteral Nutrition (ESPEN): Guidelines increased the protein requirements of cirrhotic patients and recommended 1.2 g of protein per kg body weight/day. Guidelines state that hepatic encephalopathy should not be the reason to limit protein content of diet to 1-1.5 g of protein per kg body weight/ day unless protein restriction is for very short time and is applied with BCAA-enriched amino acid supplements/solutions.

Liver cirrhosis patients should receive sufficient energy (35-40 Kcal/kg/d) to prevent degradation of endogenous protein for energy, and upto 1.6g of protein per kg body weight/day.

**Table 1. Source: What diet should I recommend my patient with Hepatic Encephalopathy?**  
Published online 2020 Mar 5. doi: 10.1007/s11901-020-00510-4  
PMCID: PMC7810167 NIHMSID: NIHMS1572465

Jawaid Shaw, MD, FACP, Victoria Tate et al.

Comparison of the Macronutrient and Micronutrient Recommendations from various organizations

| Organizations | Calorie Recommendation | Protein Recommendation | Micronutrient Recommendations                                                                                      | Remarks                                                                                                                       |
|---------------|------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| ISHEN(12)     | 35–45 kcal/kg/day      | 1.2–1.5g/kg/day        | MVI supplementation in decompensated cirrhosis, replete electrolytes like magnesium and sodium, IV Thiamine for WE | Uses Ideal body weight<br>MVI's are safe and cheap to use<br>sodium correction should be done slowly                          |
| AASLD(13)     | 35–40 kcal/kg/day      | 1.2–1.5g/kg/day        | Use MVI's, replete deficient micronutrients, zinc supplementation for HE and thiamine for WE                       | Uses ideal body weight<br>High dose IV thiamine for WE                                                                        |
| EASL(1)       | 35 kcal/kg/day         | 1.2–1.5g/kg/day        | Assess for vitamin D deficiency and if found treat accordingly                                                     | Uses actual body weight corrected to ascites<br>Treat confirmed or suspected vitamin/micronutrient deficiency as per standard |

| Organizations | Calorie Recommendation | Protein Recommendation | Micronutrient Recommendations                                                                                                                          | Remarks                                                                                              |
|---------------|------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|               |                        |                        |                                                                                                                                                        | practice                                                                                             |
| ESPEN(14)     | 30–35 kcal/kg/day      | 1.2–1.5g/kg/day        | Administer micronutrients for confirmed/suspected deficiency of Vitamin A & Zinc.<br><br>Supplements improve dysgeusia and can improve dietary intake. | Does not specify whether to use actual or ideal body weight cautions to watch for refeeding syndrome |

**Abbreviations:** International Society for Hepatic Encephalopathy, ISHEN; American Association for the Study of Liver Diseases, AASLD; European Association for the Study of the Liver, EASL; European Society for Clinical Nutrition and Metabolism, ESPEN; Multivitamins, MVI; Wernicke’s Encephalopathy; WE, Hepatic Encephalopathy; HE, Intravenous, IV

**Tips: - Dietary Rules for patients with Hepatic Encephalopathy**

1. Eat frequent meals and snacks including snack before going to bed
2. Eat more protein upto 1.1-1.5g/kg body/day (do not restrict protein in hepatic coma stage).
3. Restrict sodium-Total 3gram salt/day- patients have fluid (ascites).
4. Stop drinking alcohol
5. Stay hydrated (if ascites is present discuss to doctor)
6. Don’t start any supplements or herbal supplement without consulting hepatologist or a dietician.
7. Exercise as tolerated will complement nutritional status.
8. Discuss dietary plan during the entire visits with hepatologist/dietician.
9. Adhering to diet plan as advised.

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## 9.9 LET US SUM UP

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In this unit, we examined the role of nutrition in managing hepatic problems, focusing on conditions that affect liver health. Starting with an introduction to the structure and functions of the liver, we explored how it plays a vital role in metabolism, detoxification, and nutrient storage. Specific liver conditions were discussed in detail, including jaundice, hepatitis, fatty liver disease, liver cirrhosis, and hepatic coma. For each condition, we covered their etiology, symptoms, diagnostic approaches, and nutritional management strategies. Emphasis was placed on the importance of tailored dietary interventions to support liver function, alleviate symptoms, and promote recovery. This unit underscores the critical role of nutrition in the prevention and management of hepatic disorders, providing students with comprehensive insights into the dietary care required for maintaining liver health.

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## **9.10 CHECK YOUR PROGRESS**

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1. Conduct general nutritional assessment among students (using SGA for at least 10 students).
2. Prepare an exchange list of 5gm protein for each serving size.
3. Prepare a diet plan for jaundice, hepatitis and cirrhosis patient.
4. Learn and memorise recommended dietary allowances for Indians.
5. Prepare notes on liver functions and its role in metabolism referring to different sources.

## **Block -1V**

**Unit 11-** Nutrition in gastrointestinal (GI) disturbances is crucial for managing conditions like irritable bowel syndrome (IBS), celiac disease, crohn's disease, or gastritis. Dietary approaches often involve identifying and avoiding trigger foods that exacerbate symptoms. Fibre intake may be adjusted based on the specific GI condition, and probiotics may be recommended to support gut health. For certain conditions like celiac disease, a strict gluten-free diet is essential. Overall, nutrition plays a central role in alleviating GI symptoms, promoting gut healing, and improving quality of life for individuals with these disorders.

**Unit12-** Nutrition in cardiovascular diseases focuses on reducing risk factors like high blood pressure, cholesterol levels, and excess weight to prevent heart disease. Key dietary strategies involve limiting saturated and trans fats, reducing sodium intake, increasing fibre-rich foods, and promoting a heart-healthy diet rich in fruits, vegetables, whole grains, and lean proteins. Additionally, omega-3 fatty acids from sources like fatty fish are encouraged for heart health. Adopting these dietary habits can help manage and prevent cardiovascular diseases while improving overall cardiovascular well-being.

**Unit13-** Nutrition in hormonal disturbances involves dietary adjustments to manage conditions influenced by hormonal imbalances, such as thyroid disorders, PCOS, and diabetes. These adjustments typically focus on controlling blood sugar levels, managing weight, and optimizing nutrient intake through a balanced diet tailored to each specific condition. Consultation with healthcare professionals, including endocrinologists and registered dietitians, is crucial to create effective and personalized nutrition plans for hormonal health.

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## UNIT-10 : NUTRITION IN RENAL DISEASES

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### Structure

- 10.1 Introduction
- 10.2 Structure of the Kidneys
- 10.3 Functions of Kidney
- 10.4 Kidney Failure
  - 10.4.1 Symptoms
  - 10.4.2 Diagnosis of Kidney Diseases
  - 10.4.3 Definition of Pem/Pew
  - 10.4.4 Goal of Dietary Management in Kidney Diseases
- 10.5 Renal Calculi
  - 10.5.1 Symptoms
  - 10.5.2 Etiology of Renal Calculi
  - 10.5.3 Nutritional Management of Renal Calculi
- 10.6 Nephrotic Syndrome
  - 10.6.1 Symptoms of Nephrotic Syndrome
  - 10.6.2 Dietary Goal in Nephrotic Syndrome
- 10.7 Glomerulonephritis
  - 10.7.1 Symptoms of Acute Glomerulonephritis
  - 10.7.2 Symptoms of Chronic Glomerulonephritis
  - 10.7.3 Dietary Goal in Glomerulonephritis
- 10.8 Let Us Sum Up
- 10.9 Check Your Progress

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### 10.1 INTRODUCTION

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The kidneys are vital organs responsible for maintaining the body's internal environment by regulating fluid balance, electrolytes, acid-base homeostasis, and the excretion of metabolic waste products. Renal diseases, including acute kidney injury (AKI), chronic kidney disease (CKD), and end-stage renal disease (ESRD), significantly impair these functions, leading to systemic imbalances and life-threatening complications. Nutritional management is a cornerstone in the care of individuals with renal disorders, as it plays a crucial role in mitigating disease progression, managing symptoms, and improving quality of life. Proper dietary interventions can help control blood pressure, reduce proteinuria, and manage metabolic disturbances such as hyperkalemia, hyperphosphatemia, and uremia, which are common in renal diseases. Moreover, the nutritional needs of patients vary based on the stage and type of renal dysfunction, requiring a personalized approach to macronutrient and micronutrient intake, fluid management, and dietary restrictions. This chapter explores the complex interplay between nutrition and kidney health, focusing on evidence-based dietary strategies to support renal function and optimize patient outcomes across the spectrum

of renal diseases.

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## 10.2 STRUCTURE OF THE KIDNEYS

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The human excretory system comprises of two kidneys, two ureters, urinary bladder and urethra. The kidneys (also known as retroperitoneal organs) are bean shaped; about the size of an adult fist, are located at the back of the abdominal wall between the level of the T12 and L3 vertebrae. In order to accommodate the liver, the right kidney is placed a little lower than the left kidney.

The kidneys have an outer convex surface and inner concave surface. The renal artery enters and the renal vein and ureter leave the kidney via a notch called hilum present at the inner concave side.

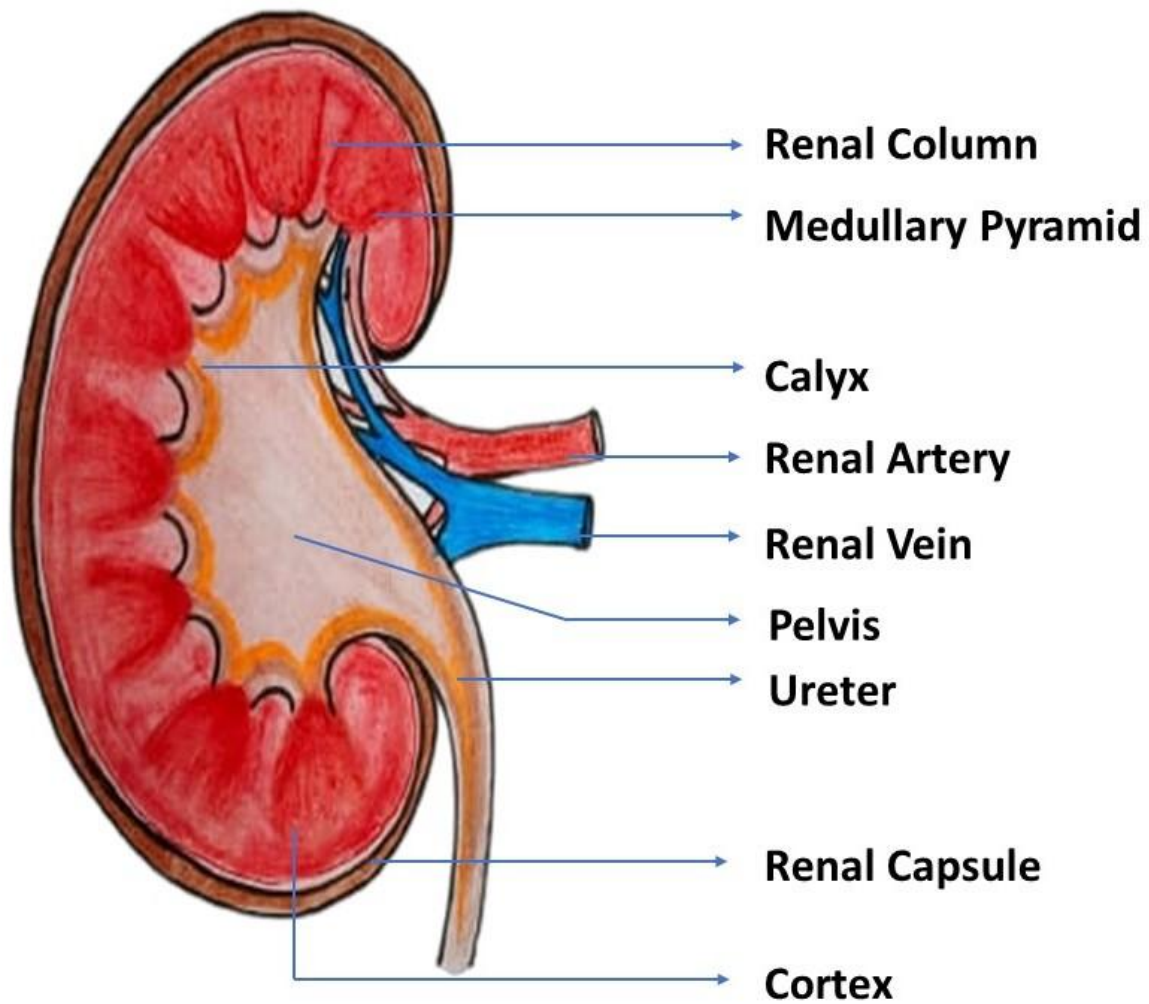
A thin fibrous connective tissue, **renal capsule** surrounds each kidney to protect them from infections and damages. A sheet of adipose tissue surrounds the capsule which is further enclosed by a layer of fibrous membrane known as **renal fascia**. The **cortex** is a reddish-brown layer of tissue below the capsule and comprises of renal corpuscles and convoluted tubules.

The **Medulla** is the innermost layer, consisting of conical areas called the **renal pyramids** separated by **renal columns**. The apex of each pyramid is called a **renal papilla**, and each papilla projects into a small depression, called a **minor calyx** (plural calyces). Several minor calyces unite to form a **major calyx**. The major calyces join to form a funnel shaped structure called **renal pelvis** that collects urine and leads to ureter. Nephrons flow between the renal cortex and inner renal medulla. Each nephron includes a filter, called the glomerulus, and a tubule. The glomerulus filters blood, which enters the kidneys through the renal arteries and leaves through the renal veins.

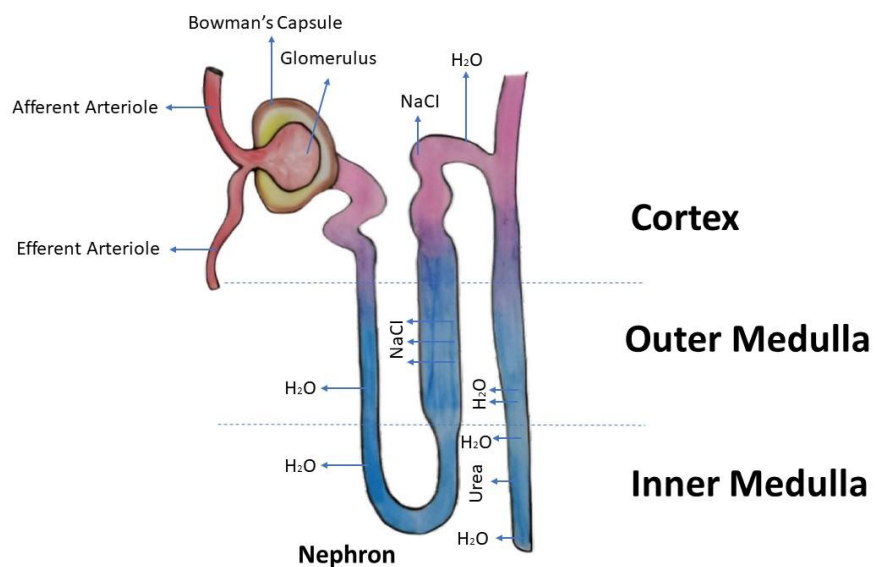
Each kidney has nearly one million complex tubular structures called **nephrons** (Figure 9.1), which are the functional units. Each nephron has two parts – the glomerulus and the renal tubule. **The glomerulus** is a cluster of capillaries that absorb protein from blood traveling through the renal corpuscle. The renal tubule begins with a double walled cup-like structure called **Bowman's capsule**, which encloses the glomerulus. The remaining fluid, called capsular urine, passes through the Bowman capsule into the renal tubules. The tubule returns necessary substances to the blood and removes waste that then becomes urine.

Each tubule has several parts like **proximal convoluted tubule, loop of Henle and distal convoluted tubule** and collecting duct present at the end of each nephron in the renal medulla. Once in the collecting duct, the fluid moves on and finally stops in the renal pelvis.

In the innermost part of the kidney there is a funnel-shaped space known as renal pelvis. The first part of the renal pelvis comprises the calyces which are small cup-shaped spaces that collect fluid prior to it moves into the bladder. **The renal artery** brings oxygenated blood from the heart to the kidney whereas the **renal vein** carries filtered blood from the kidneys back to the heart. The ureters are urine-bearing tubes that exit the kidney and empty into the urinary bladder. Urine formation involves three main processes namely, glomerular filtration, reabsorption and secretion, that takes place in different parts of the nephron.



**Figure 9.1a: Structure of Kidney**



**Figure 1 b: Structure of Nephron**

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## 10.3 FUNCTIONS OF KIDNEY

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- The most important function of the kidney is to filter the blood for urine formation
- The kidney works as endocrine glands. It secretes enzymes renin, 1, 25-dihydroxycholecalciferol, erythropoietin etc.
- Regulation of red blood cell production through erythropoietin
- Regulation of blood pressure through renin enzyme
- Elimination of metabolic toxins, waste products, drugs and excess water through urine
- Acid base balance of blood by regulating pH balance (by reabsorbing bicarbonate from urine and excreting hydrogen ions and acid ions into the urine)
- Produce an active form of vitamin D3 (1, 25-dihydroxycholecalciferol) which is important for absorption of calcium and hence promotes strong and healthy bones
- Regulation of electrolytes and minerals
- Regulate osmotic pressure (osmoregulation) in the body by maintaining fluids and electrolyte balance
- Selective reabsorption of glucose, amino acids, fluid, bicarbonates, and electrolytes in the renal tubules

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## 10.4 KIDNEY FAILURE

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Renal failure is the inability of the kidneys to excrete the daily load of wastes. The failing kidney also loses the ability to handle excessive amount of fluids.

Chronic kidney disease (CKD) is kidney damage for  $\geq 3$  months as defined by structural or functional abnormalities of the kidney, with or without decreased GFR or  $\text{GFR} \leq 60 \text{ ml/min/1.73m}^2$  with or without kidney damage for  $\geq 3$  months. CKD is classified based on the cause, GFR category (G1–G5), and albuminuria category (A1–A3), abbreviated as CGA

### **Risk factors for kidney disease:**

- Diabetes mellitus
- Hypertension
- Family history of kidney failure (inherited diseases such as ADPKD)
- Old age
- Childhood kidney disease
- History of taking pain killers for long duration including non steroidal anti-inflammatory drugs (NSAIDs).
- Abnormal kidney structure
- Glomerulonephritis or pyelonephritis
- Deformities at birth that occur as a fetus develops;
- Lupus and other immune illnesses
- Obstructions such as kidney stones, prostatomegaly

- Recurrent urinary tract infections

#### 10.4.1 SYMPTOMS

Many people may not have any severe symptoms until their kidney disease is much progressive in nature. Kidney disease may cause a wide array of symptoms. The most common symptoms are:

Anorexia (loss of poor appetite), nausea, vomiting, progressive weakness and early fatigue, altered palate sensation, food repugnance, taste alterations, dysgeusia (feeling of metallic taste) dryness of mouth trouble concentrating, trouble sleeping nocturnal muscle cramping, restless legs, poor concentration, pedal edema (swollen feet and ankles), facial puffiness. Puffiness around eyes, especially in the morning, impaired gastric emptying, impaired intestinal motility, haematuria (blood in urine), frothy urine, pruritus (itchy dry skin), and polyuria especially at night, decreased urine output, weight loss (loss of muscle mass, wasting) and hypoproteinaemia (hypoalbuminaemia)

Sometimes few nutritional deficits may also be noticed in these patients like angular stomatitis, cheilosis, rickets, osteomalacia, anaemia and pale coloured nails etc.

#### 10.4.2 DIAGNOSIS OF KIDNEY DISEASES

Laboratory tests are essential for the diagnosis of CKD.

**Blood test: Kidney function tests like haemoglobin, urea, creatinine, sodium potassium, total protein, albumin, Globulin, calcium, phosphorus, PTH, uric acid, chloride, alkaline phosphatase**

**Urine examination:** Urine analysis for clarity, colour, microscopic examination, pH, specific gravity, osmolality and presence of abnormal constituents like blood protein etc.

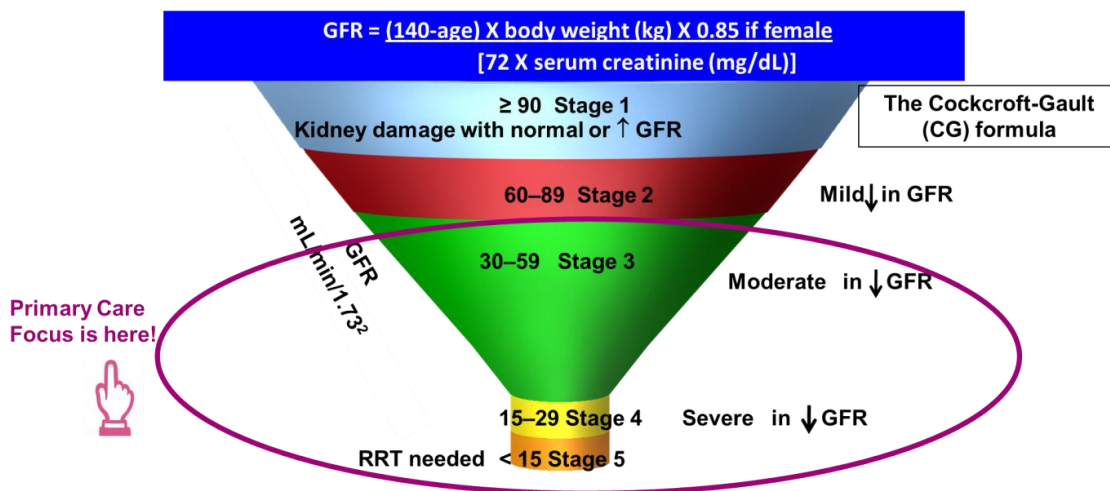
**Urine electrolytes:** Like sodium, potassium, magnesium especially in tubular diseases, where additional loss may occur.

**Imaging tests:** Imaging tests allow viewing at the kidneys and the surrounding areas to identify anomalies or blockages. Common imaging tests may include kidney ultrasonography (USG), CT scans, urogram and MRI to get a clear image of the kidneys and urinary tract to assess the size and shape of the kidney to identify kidney or urinary tract structural abnormalities. CT scans are not a common choice in view of nephrotoxic dyes used in performing the test.

**Kidney Biopsy:** It is performed in some cases to check for a specific type of kidney disease or for more precise diagnosis of kidney disease.

**Glomerular Filtration Rate (GFR):** This shows how well a person's kidney is filtering waste products and it is used for assessing the stages of kidney disease.

**Stages of CKD:** GFR is comprehensively accepted as the measure of renal function. The CKD stage is defined by the level of GFR value. The lower GFR denotes the higher stages of CKD. The national kidney foundation (NKF) divided CKD into five stages depending on GFR values calculated using the CG (Cockcroft – Gault) equation. The renal replacement therapy (RRT) is required when GFR falls below 15 (stage 5) or end stage renal disease (ESRD).



**Fig 2: Partially adopted from Coresh et al: JAMA Nov 7, 07; 298(17):2038-2047.**

The 2012 KDIGO CKD classification recommends details about the cause of the CKD and classifies it into 6 categories based on glomerular filtration rate (G1 to G5 with G3 split into 3a and 3b). It also includes the staging based on three levels of albuminuria (A1, A2, and A3), with each stage of CKD being sub-categorized according to the urinary albumin-creatinine ratio in (mg/gm) or (mg/mmol) in an early morning “spot” urine sample.

As per the latest classification of CKD the 6 categories of CKD include:

- G1: GFR 90 ml/min per 1.73 m<sup>2</sup> and above
- G2: GFR 60 to 89 ml/min per 1.73 m<sup>2</sup>
- G3a: GFR 45 to 59 ml/min per 1.73 m<sup>2</sup>
- G3b: GFR 30 to 44 ml/min per 1.73 m<sup>2</sup>
- G4: GFR 15 to 29 ml/min per 1.73 m<sup>2</sup>
- G5: GFR less than 15 ml/min per 1.73 m<sup>2</sup> or treatment by dialysis

The three levels of albuminuria include an albumin-creatinine ratio (ACR)

- A1: ACR less than 30 mg/gm (less than 3.4 mg/mmol)
- A2: ACR 30 to 299 mg/gm (3.4 to 34 mg/mmol)
- A3: ACR greater than 300 mg/gm (greater than 34 mg/mmol).

This CKD classification has been advantageous in recognising prognostic indications linked to reduce renal function and augmented albuminuria. Though the disadvantage of this classification is potential overdiagnosis of CKD in the elderly population

Protein energy wasting most probably starts at stage 3 CKD or even before partly because of insufficient and inadequate dietary management during the pre-dialysis period and it becomes clinically obvious and noticeable when the GFR falls below 15-10 ml/min. The end stage renal disease (ESRD) patients often develop a variety of metabolic and nutritional anomalies and majority of them show signs and symptoms of PEW.

#### **10.4.3 DEFINITION OF PEM/PEW**

International Society of Renal Nutrition and Metabolism (ISRNM) defined protein energy wasting as the state of reduced body stores of protein and energy fuels. Malnutrition is considered to be a

foremost reason of morbidity and mortality in CKD patients.

**Prevalence of malnutrition:** Various studies and data using standard measures of nutritional assessment have reported that a prevalence rate of approximately 18–75% in CKD patients on maintenance dialysis. Prevention, diagnosis and treatment of uremic malnutrition necessitate well-timed and suitable nutritional intervention. It is recommended and crucial to assess, evaluate and monitor the nutritional status of patients as an on-going process

**Causes of malnutrition:** The etiology of malnutrition in CKD patients is multifactorial. Malnutrition may be a result of uremic condition or may be associated with various comorbidities present. It may also be due to insufficient dietary intake owing to anorexia, nausea or vomiting. Dialysis, inadequacy, gastroparesis especially in diabetic patients etc may contribute to the pre-existing malnutrition. Dialysate losses of proteins and amino acids or abdominal distension due to glucose absorption (in case of peritoneal dialysis) may be responsible for malnutrition.

**Methods for malnutrition assessment:** Screening and assessment of nutritional status is of paramount importance for improving overall clinical outcomes in renal failure patients. It should be assessed with amalgamation of valid, complementary methods as compared to any single method only. A single measure is not sufficient enough to give a complete assessment of protein-energy malnutrition.

The Nutrition K/DOQI proposed a panel of the nutritional index that should be used in these patients

| S.No. | Category                                                                                           | Measure                                                          | Minimum Frequency of Measurement  |
|-------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------|
| I.    | Measurements that should be performed routinely in all patients                                    | Predialysis or stabilized serum albumin                          | Monthly                           |
|       |                                                                                                    | % of usual post hemodialysis (HD) or post-drain (PD) body weight | Monthly                           |
|       |                                                                                                    | % of standard (NHANES II) body weight                            | Every 4 months                    |
|       |                                                                                                    | Subjective Global Assessment (SGA)                               | Every 6 months                    |
|       |                                                                                                    | Dietary interview and/ or diary                                  | Every 6 months                    |
|       |                                                                                                    | nPNA                                                             | Monthly MHD; every 3-4 months CPD |
| II.   | Measures that can be useful to confirm or extend the data obtained from the measures in Category I | Predialysis or stabilized serum prealbumin                       | As needed                         |

|      |                                                                                                                                        |                                                                                                                                                                            |                                     |
|------|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
|      |                                                                                                                                        | Skinfold thickness                                                                                                                                                         | As needed                           |
|      |                                                                                                                                        | Mid-arm muscle area, circumference, or diameter                                                                                                                            | As needed                           |
|      |                                                                                                                                        | Dual energy x-ray absorptiometry                                                                                                                                           | As needed                           |
| III. | Clinically useful measures, which, if low, might suggest the need for a more rigorous examination of protein-energy nutritional status | Predialysis or stabilized serum <ul style="list-style-type: none"> <li>- Creatinine</li> <li>- Urea nitrogen</li> <li>- Cholesterol</li> <li>- Creatinine index</li> </ul> | As needed<br>As needed<br>As needed |

(Adapted from KDOQI, 2000)

Early detection of kidney diseases is important for prevention of malnutrition and improving the clinical outcomes and QOL in CKD patients. Dietary management is very important and considered as cornerstone in the clinical management of these patients.

#### 10.4.4 GOAL OF DIETARY MANAGEMENT IN KIDNEY DISEASES

The dietary goal should be to slow down the progression of kidney disease, improve or prevent protein energy malnutrition / wasting and also to prevent / treat comorbidities (if present) like diabetes, hypertension, dyslipidaemia and cardiovascular disease, anaemia, metabolic acidosis, secondary hyperparathyroidism. A good meal plan with appropriate dietary choices can also minimize build-up of waste products and fluid between the dialysis treatments, improve nutritional and functional status, preserve muscle mass / lean body mass, maintain electrolyte balance. The emphasis should not only be to augment the nutritional needs and also to improve the quality of diet consumed.

**Assessment of dietary intake in kidney diseases:** The energy and protein intake in adults with CKD 3-5D should be assessed properly. The K/DOQI guidelines suggest 3-day diet recall as a preferred method to assess energy and protein intake conducted on both the dialysis as well as the non-dialysis days. However, 24-hour dietary recall, food frequency questionnaires, and PCR might also be used as an alternative method for assessing dietary intake in renal failure patients. Symptoms of anorexia, nausea, vomiting, dietary habits and dietary pattern, frequency and timing of the meals eaten, quantity and quality of food ingested and fluid balance should be properly and carefully evaluated and compared with that of the recommended intake so that the nutritional gap can be filled through individual dietary counselling by an expert and skilled dietician.

**Body weight estimates** are used to estimate the dietary needs of kidney patients as the standard reference norms in chronic kidney disease patients are lacking. The guidelines suggest that clinical judgment should be used to decide the method for measuring body weight [eg, whether to use the actual measured weight or history of weight changes (whether patient has gained weight, lost weight or there is no change in the body weight) or sequential weight measurements. Post dialysis weight should be used in maintenance hemodialysis and post drain weight should be used in peritoneal dialysis patients to calculate the nutritional requirement. Adjusted edema free body weight (BW<sub>ef</sub>) should be used for the patients who have an edema free body weight <95% or > 115% of the median standard weight, as determined from NHANES II data.

**(aBW<sub>ef</sub>) = BW<sub>ef</sub> + [(SBW - BW<sub>ef</sub>) x 0.25]**

BWef actual edema free body weight                      SBW standard body weight

One has to be careful and able to distinguish between dry weights changes versus fluid shifts. The dry weight should be calculated carefully to accurately calculate the nutritional needs of these patients.

**Energy Intake:** Adequate amount of energy is needed daily to spare protein and to prevent malnutrition and wasting in kidney patients. The recommended calorie intake is 35 kcal/kg/day for patients less than 60 years of age and 30-35 kcal/kg/day for patients aged more than 60 years. Restriction of total energy intake is recommended for overweight or obese patients or if the patient is more than 65 years and who is likely to have a sedentary lifestyle. The KDOQI guidelines 2020 recommend 25-35 kcal/kg of energy intake for metabolically stable CKD patients from stage 1-5D (1C) based on age, gender, level of physical activity level, body composition, goals of weight gain or loss, stages of CKD, and presence of comorbidities or inflammation in order to maintain nutritional status.

**Dietary protein Intake:** Several studies have documented that majority of Indian patients are vegetarian and consume much less protein than that recommended by the NIN and ICMR. The concern is not only the quantity of dietary protein but also the quality of dietary protein consumed. Protein restrictions should not be customarily advised without estimating the total dietary protein intake in these patients. Providing sufficient calorie in the diet is essential for protein sparing action. When quantity of protein in the diet is limited, emphasis should be on improving the quality of protein consumed.

**Dietary Protein intake for non-dialyzed patients with CKD stages IV and V:** K/DOQI guidelines suggest that for CKD patients with GFR less than 25 ml/min and not undergoing any dialysis modality, a well-planned low protein diet comprising of a protein intake of 0.6 g/kg/day should be used. However, a dietary protein intake of 0.75 g/kg/day may be suggested for those patients who will not be able to accept such diet and not able to maintain adequate dietary energy intake. A dietary protein intake of 0.6-0.8 g/kg/day may be prescribed for diabetic CKD patients on conservative management and not on dialysis to optimize glycemia as well as to maintain nutritional status.

**Type of dietary proteins:** The previous guidelines mainly emphasize on the fact that consumption of fifty percent of the total dietary protein intake should be from high biological value protein.

There is inadequate evidence and data to recommend a particular protein type considering their impact on the nutritional status, or their effect on the lipid profile, serum calcium or phosphate levels in these patients. Based on this fact, the newer KDOQI 2020 guidelines suggest that total calorie and protein intake should be met depending on the preference of the patients for animal or plant protein. The diet of these patients should also supply sufficient amount of essential amino acids in the diet. A judicious combination of vegetarian diets with animal food items like egg whites, low fat milk, milk products and lean meat will be able to meet all the required macro and micronutrient.

**Meeting protein needs:** The total dietary protein intake should be estimated before making any dietary modifications in these patients. The vegetarian patients may be allowed to continue to eat their regular diet without over restricting their usual protein intake if it is within the recommended dietary allowances. Similarly diet of the patients eating non-veg foods frequently should also be assessed and necessary modifications may be made accordingly. Consumption of non-veg foods can be continued by replacing the other protein source in that particular meal with the non-veg food in frequency and quantity advised by dietician while making a balance of other nutrients and minerals. Self-made restrictions and any food myths contributing to pre-existing malnutrition should also be assessed and rectified.

**Protein requirement in dialysis patients:** Protein requirement increases in patients undergoing dialysis treatment. There are losses of protein during dialysis. Around 1 to 3 g per hemodialysis session and 5-15 g/day in peritoneal dialysis. The protein losses increase during the episodes of peritonitis in case the patient on peritoneal dialysis.

The latest KDOQI guidelines recommend prescribing 1.0-1.2 g/kg /day protein for maintaining the nutritional status in non-diabetic and diabetic metabolically stable CKD patients on maintenance haemodialysis or peritoneal dialysis. Higher dietary protein intake may be required for patients who are at the risk of developing hyperglycaemia and/or hypoglycaemia in order to maintain euglycemia.

**Improving the quality of vegetarian protein:** vegetarian proteins are considered as incomplete protein or low biological value protein because they are lacking in one or more amino acids. Various sources of vegetarian proteins should be selected and combined with each other judiciously. The relative insufficiency of a particular amino acid (AA) of any vegetarian food can be overcome by thoughtful combination with other vegetarian food items having adequate level of that limiting AA. Moreover, the nutritive value of a mixture of two proteins will be higher than arithmetic average of the individual values by improving the quality of vegetarian proteins.

The quality of rice protein (defined in terms of biological value, digestibility coefficient, net protein utilization and protein efficiency ratio) seems to be better than wheat protein. Moreover, the quantity of protein is low in rice compared to wheat so rice should be included in the diet of CKD patients. Amount of rice may be exchanged wisely with other sources of carbohydrate (like wheat chapatti) adjusting the total amount of carbohydrate in diabetic CKD patients to maintain blood glucose level.

**Dietary carbohydrates:** Diet of CKD patients should include sufficient amount of carbohydrate to meet the energy requirement for prevention of starvation, ketosis and for reducing protein catabolism (protein sparing effect).

**Dietary carbohydrate intake in diabetic CKD patients:** The quantity, quality as well as timing of carbohydrate consumed are significant in diabetic CKD patients as it is the major determinant of postprandial glucose excursion in these patients. The amount of carbohydrate should be kept fairly constant for every meal for patients taking the fixed dose of insulin or on oral hypoglycemic agents so that insulin dose can be adjusted around constant carbohydrate intake rather than carbohydrate being changed to meet insulin schedule. Patients must be encouraged to consume meals at regular time. Two-hour postprandial blood glucose levels should be monitored in the patients having normal premeal blood glucose levels but have deranged HbA1c.

For proper management of blood glucose level in diabetic CKD patients, nutrition education and training should be imparted to them on regular basis regarding carbohydrate counting, food exchange list, experience-based estimation of portion sizes, reading food labels, use of food pyramid, healthy food plate, measuring cups and spoons or suitable food scale to help them choose right quantity and quality of food. Educating them regarding use of glycemic index and glycemic load may provide additional benefit for glycemic control.

**Dietary fat Intake:** CKD patients are likely to have atherogenic lipoprotein profile once renal function starts decreasing. As per NKF-KDOQI guidelines the dietary approach to dyslipidaemia in CKD patients should be the similar to persons without renal failure. The American Heart Association recommends that the total fat should be 20-30 % of total energy intake, PUFA should be less than 10 %, SFA should not be more than 7 – 10 % and intake of trans fats should be less than 1% of total energy intake. The dietary cholesterol intake should be 200-300 mg per day. Modification may be done depending on the weight, metabolic profile, current dietary intake and individualized treatment goals.

A judicious combination of cereals, pulses, vegetables, low fat milk and milk products and variety of

vegetable oils helps in maintaining a desirable P/S fats ratio (~0.8-1.0) and it is cardio protective also. Moreover, fat from varied sources is always better than any single type of oil to provide optimal essential fatty acid but moderation is the key.

**Dietary Potassium Intake:** Causes of hyperkalemia (high serum potassium level in the blood) need to be identified and rectified after taking detailed dietary history from patients and reviewing the medicine prescription. Possible causes could be excessive intake of potassium rich foods, chronic constipation, Infection, GI bleeding, hyperglycemia, metabolic acidosis, drug nutrient interactions, decreased urinary output, chewing tobacco, use of salt substitute and use of ACEi /ARBs.

40-70 mEq of dietary potassium may be used for CKD stages IV and V: The ADA 2020 recommends less than 60 mEq/day of potassium for hyperkalemia. After taking a diet recall identify the high potassium foods and offer suitable alternatives containing low potassium try to make diet achievable and palatable.

In case of hyperkalaemia, low potassium fruits and vegetables should be advised and limit the foods with high potassium content. Leaching of pulses and vegetables should not be routinely advised in all patients. It should be done only in patients with hyperkalemia (high serum potassium level). Salt substitute should be avoided.

The latest guidelines recommend limiting the dietary sodium intake to less than 100 mmol/day or less than 2.3 g/day of sodium to decrease blood pressure and improve volume control as well as to decrease proteinuria to sustain desirable body weight in patients with CKD stage 3 to 5D.

The important point to keep in mind is that serum sodium is not always a trustworthy marker of dietary sodium intake in renal failure patients with volume overload as it can dilute an elevated level (dilutional hyponatremia) so the serum sodium levels must be evaluated in concurrence with fluid status in these patients.

**Salt Intake:** The salt intake should be restricted in these patients and foods high in dietary sources of sodium should be avoided.

**Practical aspects of reducing salt in the diet:** The patients should be educated and encouraged to reduce the amount of salt used in cooking and preparation of meals, steadily over a period of few weeks so that the taste buds get adopted. Meals should be prepared from fresh ingredients adding only a recommended amount of salt but none afterwards or prepare the foods without salt and add prescribed quantity later on. Limit or avoid foods rich in sodium like achar, papad, chutney, sauces, salted nuts and salted butter, ready to eat meals/ processed food /canned food/junk and fast foods / meals prepared with Mono Sodium Glutamate.

**Maintaining the palatability of the food:** The dietary intake should not be compromised by over restriction of the salt and dietary sodium. To make low salt diet palatable spices /herbs and condiments like ginger, garlic, onion, lemon, kokum/ tamarind /lemon/grated raw mangos and vinegar, cinnamon, cloves, nutmeg, cumin and black pepper (portion size matters after adjusting the potassium, sodium content). Emphasis should be placed on encouraging to read the food labels

**Dietary Phosphorus Intake:** Hypophosphatemia (high serum phosphorus level) is common and constant challenge in the clinical management of CKD patients. K/DOQI 2020 guidelines recommend that dietary phosphorus intake should be adjusted to maintain normal serum phosphate levels in patients with renal failure. Individualized and Intensive dietary counselling should be done for proper, adequate nutritional knowledge and awareness of various dietary sources and their bioavailability.

**Food sources and bioavailability of phosphorus:** Both animal and plant protein sources contain organic phosphorus. Approximately 40 – 60 % of organic phosphorus is absorbed. Bioavailability of phosphorus is better in animal food items (~70 %) as compared to phosphorus bioavailability from plant-foods (less than 50%) because of the presence of phytates which is not readily and easily bioavailable.

Foods sources comprising certain beverages like colas, snack bars, frozen meals, processed or spreadable cheeses, enhanced meats, instant food items, and frozen bakery products are rich in inorganic phosphorus which are readily bioavailable (> 90 % Inorganic phosphorus is being absorbed). Bioavailability of phosphorus from a typical mixed diet is 55-70 %.

The benefit of low bioavailability (low intestinal absorption) of phosphorus from plant-based food items should not be overlooked when preparing a diet chart restricted in phosphorus but adequate in protein for dialysis patients for controlling hypophosphatemia.

Phosphorus from the food additives is almost completely bioavailable for absorption by the body which imposes additional phosphorus burden. The patients must be educated and encouraged to search for the word “phos” on ingredient lists for hidden phosphorus content.

**Phosphorus to protein ratio:** The K/DOQI guidelines recommend the use of phosphorus to protein ratios for proper control of dietary phosphorus. These composition tables are also beneficial for limiting the intake of high phosphorus foods without compromising intake of adequate amount of dietary proteins. Limiting the non-protein sources of phosphorus seems like better strategy and is more effective in the prevention or improvement of malnutrition. Egg white has lowest phosphorus to protein ratio of 1.46 : 1. It should be included in the diet. Besides being lowest in phosphorus to protein ratio it is the reference protein also.

**Controlling hyperphosphatemia:** As GFR decreases, level of phosphorus increases in the blood and this elevated level of serum phosphorus stimulates the release of PTH that releases calcium from bone causing the bones to become weaker and may cause renal osteodystrophy. Therapeutic approaches directing phosphorus control consist of restriction of dietary phosphorus, reducing intestinal absorption of phosphorus by using appropriate phosphate binders with meals, and removing phosphorus with adequate dialysis. Fortunately, simple methods including soaking foods in water and boiling them helps in significant reduction of dietary phosphorus content per gram of protein in foodstuff. Source of readily absorbed phosphorus should be discouraged like beverages containing phosphoric acid (e.g. regular and diet cola's), beer and chocolate. Unfortunately phosphorus clearance by dialysis (MHD and PD) is also poor. This necessitates the demand for phosphorus binders to prevent phosphorus from being absorbed in the gut; form insoluble compound is excreted in stool. Food sources high in phosphorus can be taken at the time of consumption of phosphate binders prescribed.

**Reading Food labels:** Apart from looking for the macronutrients only the patients with CKD should be educated for developing a habit of reading food labels which help them to look for the amount of sodium, potassium and phosphorus in foods. Encourage them to check the ingredient list for potassium as sometimes sodium chloride (salt) is replaced in some foods with potassium chloride. Ingredient list must also be checked and must be evaluated for **phosphorus**, or **for words with PHOS for identifying the** hidden phosphorus as food additives. All these tips and tricks may help to control hyperphosphatemia.

**Fluid Intake:** Fluid balance is one of the very important aspects in the nutritional and clinical management of CKD and dialysis patients. Thumb rule for fluid prescription is previous day 24-hour urine output + 500 ml, if patient is dry and 24-hour urine output + 300 ml if patient is edematous. However, Fluid requirement varies significantly from patients to patients depending on many

factors. It has to be personalised depending on IDWG, blood pressure, residual renal functions and fluid restrictions may need to be increased in case there is increased IDWG or presence of CHF, edema etc

**Prevention of fluid overload:** Detailed physical examination is needed for assessing the extent of fluid overload. An extensive detail history from the patient with renal failure regarding urine output, fluid intake, ultrafiltration (in case of dialysis) compliance with dialysis exchanges [if on peritoneal dialysis (PD)] and pattern of weight gain for patients on maintenance dialysis (MHD) is a pre requisite. MHD patients must be regularly assessed for IDWG and PD patient must be reviewed regularly for weight change, urine output, ultrafiltration achieved with each PD exchange and solution toxicity (1.5 %, 2.5 % or 4.25 %) after reviewing the patient's PD record book. Modifications in their fluid intake may be done accordingly.

Patients on dialysis gain several kg of fluid between HD treatments. Fluid gain of more than 5%, may reveal excessive fluid intake leading to hypertension, edema, ascites, pleural effusion, breathlessness. Fluid gains of less than 2% indicates minimal fluid and food intake, patients may be losing body mass. Limiting the IDWG to 2-5 % estimated dry weight is a good strategy.

**Ways to limit fluid intake:** Patients must be educated to avoid salty and fried foods to decrease thirst. Instead of milk patients are suggested to use paneer or hung curd, to have thick dal or thick gravies to save the fluid allowances. Small cup or glass can be used. Fluid allowances must be spread evenly throughout the day. Medications may be taken with the meal-time liquids and not with extra water. Candy, peppermint or flavoured ice cubes can be used to quench the thirst.

**Conclusions:** Nutrition is of paramount importance at every stage of CKD for the prevention of malnutrition. All the misconceptions and myths relate to diet and food has to be corrected and clear among the patients. Individualized and patient centric realistic meal plan and dietary counselling initiating at early stages of CKD and also at commencement of dialysis with regular follow-up on-going basis with diet diaries help to prevent malnutrition in CKD patients. Holistic dietary approach rather than specific nutrient restriction is crucial. All the macro- and micro nutrients deficiencies have to be identified before they become clinically evident and prevent PEW from setting in.

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## 10.5 RENAL CALCULI

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Renal calculi or urinary calculi disease or kidney stone disease, also known as renal stone disease or nephrolithiasis is now become a public health concern. When the concentration of ions and solutes (like  $H^+$ ,  $Na^+$  and uric acid) are present in more than normal (supersaturation) amounts, kidney stones (crystalline structures) may be formed. Presence of crystallized calcium, magnesium, cysteine, or uric acid in the renal system may give rise to renal stones. The prevalence and incidence of kidney stones is rising at an alarming rate in developing countries like India. Serious discomfort may be seen as the size of renal calculi increases due to course of time, ignorance or untreated conditions which may cause substantial damage and may lead to renal injury.

### 10.5.1 SYMPTOMS

Many patients with renal calculi may remain asymptomatic. The most common symptoms associated with renal calculi are unilateral flank pain due to acute ureteral obstruction. Haematuria is commonly observed in renal calculi.

### 10.5.2 ETIOLOGY OF RENAL CALCULI

Reason for stone formation is multi-factorial. Various risk factors may include demographic and lifestyle factors, faulty dietary habits, age, race / ethnicity, consumption of salt and fluid, obesity,

insulin resistance, dehydration, presence of various co-morbidities, physical inactivity, temperature, heredities, metabolic conditions (metabolic diseases such as diabetes, metabolic syndrome, hypertension, hyperuricemia), dairy products and fast / junk food and use of various medications may be concomitant with renal calculi. Moreover, the dietary consumption of sodium, oxalate, citrate, uric acid, calcium-rich foods, protein, as well as fluids intake considered as part of the dietary characteristics linked with stones inhibition or formation.

### 10.5.3 NUTRITIONAL MANAGEMENT OF RENAL CALCULI

Understanding the associated risk factors is of utmost importance. Various dietary factors play a vital role in the risk of the developing renal calculi. Suitable dietary modifications along with pharmacological intervention for rectification of various risk factors help in the prevention of recurrent stone formation. Understanding simple dietary alterations may significantly reduce the risk of renal stones. Tailormade dietary recommendations based on metabolic evaluation aids in the renal calculi prevention. Simple dietary amendments including low salt intake, reducing tea intake, lowering junk foods consumption play a noteworthy role in renal calculi prevention.

**Oxalates:** Oxalates come from food and through the indigenous production in liver. Food sources include chocolate, nuts, tea [green/black], spinach, soya protein. Dietary modifications help in managing the intake.

Dietary treatment of calcium oxalate stones includes reducing or removing intake of dietary oxalate. Restricting cocoa drinks, chocolate, candies, black tea, excessive coffee intake, spinach, rhubarb, asparagus, celery, parsley and tomatoes. Calcium oxalate stone formers should limit intake of almonds, peanuts, cashews, walnuts, beetroot, sapota, cocoa, chocolate, tomato, strawberries, eggplant, soy products, tofu, wheat bran and rice bran.

**Water:** Adequate fluid intake is one of the most important dietary approaches to prevent stone formation. Limited fluid intake and dehydration may also contribute to renal calculi formation. Low urine production may cause supersaturation of calcium, oxalate, urate, and phosphate, which may contribute to renal stones. Increasing fluid intake leads to dilution of urine and reducing the acids concentration and decreasing the supersaturation of calcium oxalates. The various guidelines approve keeping optimal fluid intake distributed throughout the day. Appropriate hydration decreases the chances of urinary tract infections and further decreasing risk for struvite stones.

**Protein:** A dietary protein intake of 0.8 g/kg of body weight equivalent to the RDA is considered as safe intake. Adult patients with calcium oxalate stones should limit the daily intake of animal proteins.

**Sodium:** The increased consumption of sodium increases the excretion of calcium. High sodium intake increases the urinary calcium, reducing urinary citrate and promoting the induction of urate-induced calcium oxalate crystallization. In adults, the sodium intake should not exceed 2 g/day (5 g of salt/d).

**Potassium:** Restriction of dietary sources of potassium may enhance calcium excretion. Hypokalaemia reduces the urinary excretion of citrate, an important inhibitor of calcium oxalate formation. Increase consumption of potassium-rich foodstuffs like vegetables and fruits signifies an alkali load which upsurges urinary citrate excretion.

**Calcium:** It is advocated to keep the calcium intake of up to 1000 to 1200 mg/day. Supplementation with calcium may decrease bioavailability of intestinal oxalate and its absorption, lessens urinary oxalate excretion leading to hypercalciuria. Calcium intake should remain within the RDA of 800–1,000 mg/day. Calcium supplements taken between meals may increase the risk of stones and calcium consumed with meals has the reverse result decreasing the hazard of calculi.

**Hyperuricemia:** The hyperuricemia is associated with renal calculi. Foods rich in purines are derived mostly from animal protein sources may be linked with high risk of calculi, while purine-rich plant foods are not associated to stones formation, and dairy products presented reduced stones formation risk, decreasing the consumption of meat, chicken and seafood which will decrease the intake of purine and, therefore, production of uric acid increases. Higher intake of fruits and vegetables should raise urinary pH and reduce the risk of uric acid crystal formation,

**Cysteine:** Patients with cysteine stones should restrict sodium intake and increase fruit and vegetable intake. Reducing animal protein will be beneficial in increasing urinary pH. Restriction of methionine-containing foods like peanuts, pistachio, popcorns, broccoli, mushroom, cauliflower, avocado, bean sprouts, potatoes, spinach, green peas, tofu, kidney beans, black beans and tempeh may prevent cysteine crystal formation.

**Renal calculi and dietary pattern:** Dairy and vegetable foods seem to have an anti-calculi effect. The vegetarian diet has been shown to have a protective effect against kidney stone formation especially when it contains lots of seasonal vegetables and fruits, whole grains, legumes, moderate protein (0.8 g/kg/day), only little amount of animal protein, low fat milk and milk products in balanced amount, low in salt, sodium and uric acid. Adequate hydration is a pre requisite. Diet pattern analogous to the classic dietary approaches to stop hypertension (DASH) diet and the Mediterranean diet helps in renal calculi prevention. These diets are typically limited in sodium, adequate in potassium, calcium, and magnesium, and seem to have anti-calculi effects.

**Diet plan:** The individualized diet plan for patients with renal calculi should be planned depending on patients' routine, their dietary habits, socio-economic status, individual metabolic profile, type of stone (stone composition), biochemical profile, dietary intake food preferences and accessibility to various food items and modifications can be made accordingly. Adequate hydration is a must.

**Regular physical activity:** Regular physical activity should be done to maintain ideal body weight or to reduce weight if overweight or obese.

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## 10.6 NEPHROTIC SYNDROME

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It is a clinical condition or renal impairment which leads to the excretion of protein in the urine. Protein loss of more than 3-3.5 g/day customarily signpost the nephrotic syndrome. It may happen because of damage to glomerular basement membrane leading to an upsurge of glomerular permeability and subsequent loss of albumin and other plasma proteins in the urine more than normal level.

In other words, nephrotic syndrome may be defined as a medical scenario with an amalgamation of proteinuria, hyperlipidemia, hypoalbuminemia and edema.

NS is demarcated by the presence of:

- Proteinuria (urine protein excretion of either 3+ or 4+ on a urine dipstick test or a spot protein/creatinine ratio of more than 2 mg/mg, or urine albumin level of more than 40 mg/m<sup>2</sup> per h)
- Serum albumin of less than 2.5 g/dL
- Edema
- Dyslipidaemia with serum cholesterol level more than 200 mg/dl

Nephrotic syndrome may be primary disease being unambiguous to the kidneys or may be secondary as a renal manifestation of a systemic disease.

### 10.6.1 SYMPTOMS OF NEPHROTIC SYNDROME

Though the synthesis of albumin in the liver upsurges but still not sufficient enough to recompense for the urinary albumin losses leading to edema. This lower level of serum albumin actuates the hepatic synthesis of lipoprotein and cholesterol with subsequent hyperlipidemia. Simultaneously, breakdown of serum lipoproteins is decreased in the liver and excretion of HDL is augmented in the urine. Moreover, certain medicines (steroids, diuretics, and antihypertensive drugs) every so often used in the treatment of nephrotic syndrome may further aggravate the pre-existing dyslipidaemia.

The common symptoms may include edema especially near eyes and in ankles and legs, frothy urine and weight gain owing to volume overload. Sometimes ascites or pleural effusions may be present.

### 10.6.2 DIETARY GOAL IN NEPHROTIC SYNDROME

Reducing and controlling the proteinuria is the primary goal of treatment. The overall dietary goal is to lessen the associated symptoms (edema and increased lipid level in the blood), compensate the albumin losses, spare dietary proteins, decline the rate of progressive renal impairment and atherosclerosis, control hypertension (if present) through a well-planned timely, adequate and appropriated individualized dietary management. Patient centric practical dietary tips with respect to dietary management are important.

#### Dietary Management

Very high protein intensifies proteinuria and may accelerate related renal disease. Moderate dietary protein restriction not only decreases urinary protein losses but also reserves serum albumin concentration. Moreover, modest protein restriction 0.8 g/kg/day have been shown to maintain nitrogen balance.

**Weight monitoring:** dry weight should be estimated especially if edema or /and ascites is present. Growth and development have to be monitored and recorded routinely in children.

**Energy intake in adults:** Adequate energy intake is recommended, at least 30 - 35 kcal/ kg /day in adults. Calories restriction may be needed in overweight or obese patients. Adequate amount of calories is needed to achieve and maintain ideal body weight and maintain protein stores (protein sparing). Foods rich in complex carbohydrates should provide the majority of energy.

**Energy intake in Children:** In children the energy should be based on the estimated average requirement for children of the same chronological age. In simplest words the energy requirement should meet at least RDA for the normal children of same height age. Calorie intake in the diet should be sufficient enough to enhance the efficiency of protein (for protein sparing effect) and avert the children from landing into catabolic state. Height age should be used for energy estimation when use of chronological age does not account for the growth,

**Protein** According to the Indian Paediatric Nephrology Group (IPNG), a well-balanced diet, adequate in protein (1.5–2 g/kg) and calories, is recommended. Patients with persistent proteinuria should receive a dietary protein intake of 2–2.5 g/kg/day. In adults the recommendation for dietary protein intake is 0.8 g/kg/day is recommended. Dietary restriction reduces urinary elimination of proteins, decreases protein breakdown and oxidation of amino acids and hence maintains nitrogen balance. Each gram of urinary protein loss should be replaced by addition one gram of high biological value protein in the diet.

A dietary protein intake of 1.2g/kg/day is recommended to avoid hazards of growth retardation. Protein is needed for achieving positive nitrogen balance and for growth in malnourished and protein depleted children.

**FAT:** The diet plan should include low cholesterol (<200 mg), low saturated fat (<7 -10%) rich in PUFA for these patients. As per Indian Paediatric Nephrology Group (IPNG) total dietary fat should not exceed more than 30% of the total daily calories. The focus should be on maintenance of desirable body weight or loss of surplus weight if overweight or obese to decrease the jeopardy of cardiovascular disease.

**Children taking steroids:** steroid dependent children with frequent relapse may need long standing nutritional counselling as well as assessment and monitoring of nutritional status for maintenance of weight, prevention of malnutrition. Prednisolone indeed increases the appetite and hunger pangs and dietary advice regarding the prevention of obesity is vital especially for obese children and adolescents. Unhealthy food stuffs like biscuits, chips, cookies, chocolates cold drinks, french fries, pastries, patties, bakery products, burgers, pizza, and doughnuts should be avoided. Healthy eating habits should be inculcated and reinforced repeatedly at subsequent follow up with reports and diet diary.

**Potassium:** No modification is routinely needed for potassium, but potassium losses due to diuretics may require supplementation. In case of high serum potassium (if present), dietary adjustment has to be done accordingly.

**Salt, Sodium and Fluid:** Management of salt, sodium and fluid is essential for controlling edema and hypertension (if present). Patients must be educated regarding the practical approaches, tips and tricks for restricting the fluid. Majority of steroid-sensitive nephrotic syndrome patients may not require salt restriction but restriction of salt intake is recommended for patient having persistent edema. Sodium restriction of 1-g/ day is generally required for controlling edema and hypertension. A well strategic meal plan low in dietary sodium or salt aid to prevent or reduce fluid restriction. Food items high in dietary sodium have to be limited or avoided. The salt and fluid restriction are generally needed only until the patient is having a remission. Afterward the liberal fluid intake is allowed and salt intake should be restricted only if there is associated hypertension.

**Hypertension:** Optimal lifestyle modification along with salt restriction and avoiding prolonged prednisolone therapy are adequate treatment in most of the cases.

**Supplements:** Patients with nephrotic syndrome commonly show deficiency of vitamin B and Zinc and may get benefit from supplement. Children with low level of serum calcium and vitamin D intake may be associated with the risk of low bone mass. The children on steroid therapy should be supplemented with calcium and vitamin D

**Monitoring:** All the patients with nephrotic syndrome having recurrent relapse, steroid-dependent or steroid-resistant nephrotic syndrome necessitate assessment and monitoring of nutritional status. At risk or malnourished patient may require detailed anthropometry, clinical examination and biochemical evaluations in order to detect hostile effects of drugs. It is also vital to calculate the GFR. It is crucial that patients must be tracked up in subsequent visit for nutritional evaluation at regular follow up visit with diet diaries for checking the dietary compliance level and dietary modification as per requirement. Diet should not be too restrictive unnecessarily. Try to make the diet plan achievable and practical which they can follow easily,

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## 10.7 GLOMERULONEPHRITIS

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Glomerulonephritis is a cluster of diseases that damage the glomeruli filtering the blood. Acute and chronic glomerulonephritis are the two important types of glomerulonephritis. The acute glomerulonephritis develops precipitously.

### **10.7.1 SYMPTOMS OF ACUTE GLOMERULONEPHRITIS**

The initial symptoms of the acute glomerulonephritis may include facial puffiness mainly in the morning, presence of blood in the urine or brown coloured urine, micturiting less frequently. The etiology of acute illness may be due to infections such as strep throat or may be caused by other ailments comprising of lupus, Wegener's disease, good pasture's syndrome and polyarteritis nodosa. For prevention of kidney failure, it is crucial to diagnose early and treat promptly for improving various clinical outcomes.

### **10.7.2 SYMPTOMS OF CHRONIC GLOMERULONEPHRITIS**

The chronic glomerulonephritis may develop silently over a period time and often leads to renal failure. Initial signs and symptoms of the chronic glomerulonephritis may include proteinuria, hematuria, hypertension, frothy urine, facial puffiness and swelling around the eyes and edema of ankles legs or hands and frequent nocturnal micturition.

Healthy diet and optimal lifestyle modifications are vital for maintain health and to decrease the risk of developing ailments affecting kidneys. Dietary goals are to maintain ideal body weight, prevent malnutrition and wasting, slow down the progression of disease and reliving or decreasing the associated symptoms, maintaining normal blood pressure and normal blood sugar levels in diabetics. Adequate calories with moderate protein, low salt and sodium potassium and phosphorus with individualized fluid prescription.

All the causes of glomerular disease may not be preventable. However, it is essential to find out the treatable causes of illness as soon as possible treat early to sluggish the renal injury and helps to prevent it from getting worse.

### **10.7.3 DIETARY GOAL IN GLOMERULONEPHRITIS**

#### **Controlling Protein Intake:**

Glomerulonephritis often impairs kidney function, reducing the ability to filter waste products effectively. A key dietary goal is to control protein intake to minimize the production of nitrogenous waste. The amount of protein should be tailored based on the severity of kidney impairment. High biological value proteins, such as eggs, lean meat, fish, and milk, are recommended in moderate amounts to meet essential amino acid requirements without overburdening the kidneys.

#### **Sodium Restriction:**

Sodium restriction is crucial to manage edema and hypertension, which are common symptoms of glomerulonephritis. A low-sodium diet (typically 1,500–2,000 mg/day) helps control fluid retention and blood pressure. Processed and packaged foods, which are high in sodium, should be avoided, and fresh foods should be preferred. Cooking with herbs and spices instead of salt can enhance flavor while keeping sodium intake low.

#### **Managing Fluid Intake:**

Fluid management depends on the patient's urine output and the level of fluid retention. In cases of significant edema or reduced urine production, fluid intake may need to be restricted. The fluid allowance is often calculated based on the previous day's urine output plus 500–700 ml to account for insensible losses.

#### **Potassium Regulation:**

Potassium levels need careful monitoring in glomerulonephritis, especially if hyperkalemia (high potassium levels) develops due to reduced kidney function. Foods rich in potassium, such as bananas, oranges, potatoes, and tomatoes, may need to be limited if potassium levels are high. On

the other hand, if hypokalemia (low potassium levels) is a concern, potassium intake may need to be increased.

### **Maintaining Energy Levels:**

Adequate caloric intake is necessary to meet energy requirements and prevent the breakdown of body protein stores for energy. Energy can be derived from carbohydrates and fats, with a focus on complex carbohydrates, such as whole grains, fruits, vegetables, and healthy fats, such as those from nuts, seeds, and oils like olive or canola.

### **Phosphorus and Calcium Balance:**

Patients with glomerulonephritis may develop hyperphosphatemia due to impaired kidney function. This can lead to bone disorders if not managed. Foods high in phosphorus, such as dairy products, nuts, and processed foods with phosphate additives, may need to be restricted. Calcium supplements or foods fortified with calcium may be recommended to prevent bone loss, but these should be managed under medical supervision.

### **Reducing Inflammation:**

Anti-inflammatory dietary components, such as omega-3 fatty acids found in fatty fish (salmon, mackerel) and flaxseeds, may help reduce inflammation associated with glomerulonephritis. Including a variety of colorful fruits and vegetables rich in antioxidants can further support immune health and reduce oxidative stress.

### **Individualized Nutritional Plan:**

Each patient's dietary goals must be tailored based on the type and severity of glomerulonephritis, associated symptoms, lab results, and any other medical conditions. Regular follow-up with a healthcare provider, including a nephrologist and a dietitian, is essential to monitor nutritional status and adjust the diet plan as needed.

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## **10.8 LET US SUM UP**

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The kidneys are vital organs responsible for filtering waste, maintaining fluid and electrolyte balance, and regulating blood pressure. Kidney-related conditions, such as kidney failure, renal calculi, nephrotic syndrome, and glomerulonephritis, significantly impact these functions and present with symptoms like swelling, fatigue, changes in urine output, and pain. Protein-Energy Malnutrition (PEM/PEW) is common in kidney diseases, emphasizing the need for dietary management tailored to the condition. Nutritional goals focus on reducing the kidneys' workload, controlling sodium, protein, and fluid intake, ensuring adequate caloric and nutrient balance, and preventing further complications. A comprehensive understanding of these conditions highlights the critical role of diet in both prevention and management, ensuring better health outcomes and quality of life for affected individuals.

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## **10.9 CHECK YOUR PROGRESS**

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### **Short Questions**

1. What are the primary functions of the kidney?
2. Define glomerulonephritis in brief?
3. Name two common symptoms of nephrosis?
4. List any two types of urinary calculi?

5. What is the main dietary restriction in renal failure?

### **Long Questions**

1. Explain the structure and functions of the renal system and how they are affected in renal diseases.
2. Discuss the etiology, symptoms, and dietary management of acute and chronic glomerulonephritis.
3. Describe the dietary recommendations for patients with nephrosis.
4. Analyze the prevention, types, and dietary management of urinary calculi.
5. Elaborate on the stages of renal failure and the role of nutrition in managing the condition.

## **Block -IV**

### **Nutrition in Various Disorders and Diseases II**

#### **INTRODUCTION**

Nutrition during disorders and diseases is a critical component of medical care, as it can significantly impact the course of a condition, its symptoms, and the overall well-being of individuals. Nutrition during disorders and diseases is highly individualized and should be guided by healthcare professionals, particularly registered dietitians or nutritionists. These experts consider the specific diagnosis, nutritional requirements, lifestyle, and personal preferences to develop tailored dietary plans that optimize health, manage symptoms, and improve the overall quality of life for individuals facing various health challenges.

**Unit 11-** Nutrition in gastrointestinal (GI) disturbances is crucial for managing conditions like irritable bowel syndrome (IBS), celiac disease, Crohn's disease, or gastritis. Dietary approaches often involve identifying and avoiding trigger foods that exacerbate symptoms. Fibre intake may be adjusted based on the specific GI condition, and probiotics may be recommended to support gut health. For certain conditions like celiac disease, a strict gluten-free diet is essential. Overall, nutrition plays a central role in alleviating GI symptoms, promoting gut healing, and improving quality of life for individuals with these disorders.

**Unit12-** Nutrition in cardiovascular diseases focuses on reducing risk factors like high blood pressure, cholesterol levels, and excess weight to prevent heart disease. Key dietary strategies involve limiting saturated and trans fats, reducing sodium intake, increasing fibre-rich foods, and promoting a heart-healthy diet rich in fruits, vegetables, whole grains, and lean proteins. Additionally, omega-3 fatty acids from sources like fatty fish are encouraged for heart health. Adopting these dietary habits can help manage and prevent cardiovascular diseases while improving overall cardiovascular well-being.

**Unit13-** Nutrition in hormonal disturbances involves dietary adjustments to manage conditions influenced by hormonal imbalances, such as thyroid disorders, PCOS, and diabetes. These adjustments typically focus on controlling blood sugar levels, managing weight, and optimizing nutrient intake through a balanced diet tailored to each specific condition. Consultation with healthcare professionals, including endocrinologists and registered dietitians, is crucial to create effective and personalized nutrition plans for hormonal health.

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## UNIT 11 - NUTRITION IN GASTRO INTESTINAL DISTURBANCES

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### Structure

- 11.1 Introduction
- 11.2 Structure of Gastrointestinal System
- 11.3 Functions of Digestive System
- 11.4 Gastro Intestinal Enzymes
- 11.5 Disease Specific Nutritional Dietary Management
- 11.6 Diarrhoea
  - 11.6.1 Etiology of Diarrhoea
  - 11.6.2 Symptom of Diarrhoea
  - 11.6.3 Diagnosis of Diarrhoea
  - 11.6.4 Prevention of Diarrhoea
- 11.7 Constipation
  - 11.7.1 Symptom of Constipation
  - 11.7.2 Etiology of Constipation
  - 11.7.3 Treatment and dietary management Of Constipation
- 11.8 Peptic Ulcer
  - 11.8.1 Symptom of Peptic Ulcer
  - 11.8.2 Types of Peptic Ulcer
  - 11.8.3 Etiology of Peptic Ulcer
  - 11.8.4 Diagnosis of Peptic Ulcer
  - 11.8.5 treatment and dietary management of Peptic Ulcer
- 11.9 Flatulence
  - 11.9.1 Symptom of Flatulence
  - 11.9.2 Etiology of Flatulence
  - 11.9.3 Treatment and dietary management of Flatulence
- 11.10 Let Us Sum Up
- 11.11 Check Your Progress

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### 11.1 INTRODUCTION

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The gastrointestinal (GI) tract is a critical system in the human body, responsible for the digestion and absorption of nutrients, maintenance of immune function, and protection against pathogens. Disturbances in the GI system, such as gastritis, peptic ulcers, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), celiac disease, and malabsorption syndromes, can disrupt these functions, leading to significant nutritional deficiencies and overall health complications. These disorders often result in symptoms like nausea, diarrhea, constipation, bloating, and pain, which can

interfere with food intake, nutrient assimilation, and overall well-being. Nutrition plays an integral role in the prevention, management, and treatment of gastrointestinal disturbances. Tailored dietary modifications can alleviate symptoms, support the healing of the GI mucosa, and prevent malnutrition. For example, low-fiber diets are often recommended during acute inflammation, while probiotics and prebiotics can enhance gut health in certain conditions. This chapter examines the intricate relationship between nutrition and GI health, highlighting dietary strategies and therapeutic interventions aimed at restoring gut function, managing symptoms, and enhancing the quality of life for individuals with gastrointestinal disturbances.

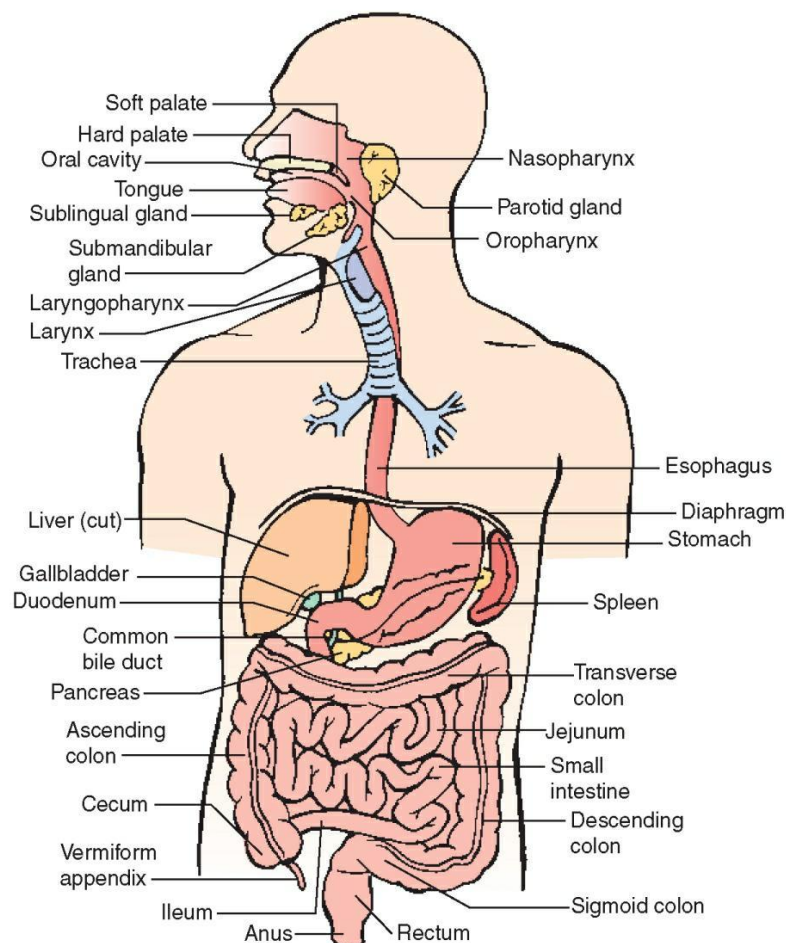
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## 11.2 STRUCTURE OF GASTROINTESTINAL SYSTEM

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The structural gastrointestinal system consists of the gastrointestinal (GI) tract along with accessory organs. The gastrointestinal tract consists of the buccal cavity, larynx, pharynx, oesophagus, stomach, duodenum, small intestine, large intestine, and anal canal. The accessory or supporting organs include teeth, tongue, and glands such as salivary glands, liver, gallbladder, and pancreas. The major functions of the gastrointestinal tract include food ingestion and digestion, essential nutrient absorption, secretion of wastes from body in form of extra water and enzymes, excretion of waste products.

The upper part of GI tract is oesophagus, the tube that connects mouth and stomach. The food goes through the oesophagus to get stored in the stomach. Stomach can hold up to a quart and a half of food and stomach cells have elastic property that can extend up to a big bag. Figure 1 shows the GI system with its accessory organs.



**Figure 1: The Gastrointestinal system. Image source: SARAH Wayt- Anatomy and physiology- The Gastrointestinal system, July 23, 2023**

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## **11.3 FUNCTIONS OF DIGESTIVE SYSTEM**

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This uniquely designed system provides constant nutrients which provide energy, building blocks and other essential nutrients to every cell of the body. These essential nutrients are achieved by breaking down food which leaving organisms, eat into small enough particles to pass into the cell membrane, known as digestion and the transformation of the small particles to the circulatory system to be carried in different parts the body, known as absorption.

Every organ in GI system plays a specific role.

**The Buccal Cavity:** Buccal cavity consists of lips, teeth, lining inside the cheeks, tongue, salivary glands, upper and lower palate which anatomically perform different aspects that work collectively, effectively and efficiently several functions. Oral cavity or buccal mucosa is lined by keratinized epithelium which consists of superior surface of the tongue and hard palate and other nonkeratinized squamous epithelial cells consists of lips, cheeks and inferior surface of tongue, none of them are known to aid in absorption, except for mucosa inferior to tongue. The actions performed in buccal cavity are mastication, which is chewing on food to physically break it into small chunks. This process is also referred to as mechanical digestion during mastication and chewing.

Here the first most function is sensory evaluation of the food which we eat then before swallowing and mechanical processing with help of the teeth, tongue, the palate surfaces. Buccal cavity helps in lubrication by allowing food to mix with salivary glands secretions, mucus which perform limited breakdown of carbohydrates and lipids in mouth.

**Functions of the tongue:** Tongue mechanically process the food by compression, distortion abrasion and manipulation to help in chewing, preparing food material for swallowing. Tongue has very unique function of sensory analysis of touch, temperature feeling and taste receptors, then secretion of enzymes like mucins and lingual lipase. lingual lipase has broad pH that breaks down lipids (triglycerides).

Buccal cavity, has three 3 of salivary glands:

1. **Parotid salivary glands:** located inferior next to the zygomatic arch and posterolateral to the mandible. Parotid glands produce a large amount of salivary amylase which breaks down carbohydrate into simpler forms.
2. **Sublingual salivary glands:** these are located on the floor of mouth. The sublingual glands produce a secretion that is both a buffer and lubricant.
3. **Submandibular salivary glands:** are located on the floor of mouth within mandibular groove. They secrete a mixture of buffers, glycoproteins which is known as mucins, and salivary amylase.

**Oesophagus:** After the food being swallowed, peristalsis movement pushes the food down via oesophagus into stomach.

**Stomach:** The stomach is meant to store, churn, makes pureed food into a substance known as chyme. Gastric juices are secreted by cells of the stomach, contributing to chemical digestion. Muscles of stomach mix the food with the digestive juices secreted by stomach.

**Pancreas:** Pancreas makes three kinds of digestive enzymes known as lipase, protease, and amylase that break down carbohydrates, fats and proteins. The beta cells of the islets of Langerhans that secrete hormone insulin. The pancreas disposes these enzymes and hormone into the small intestine

via duodenum through tubes called ducts.

**Liver:** The largest gland or organ in the human body is liver which performs more than 500 functions in body. Liver makes a digestive juice called bile that helps in digestion of fats and some vitamins. The bile duct carries bile from liver to gallbladder for extra storage, and to small intestine for further use.

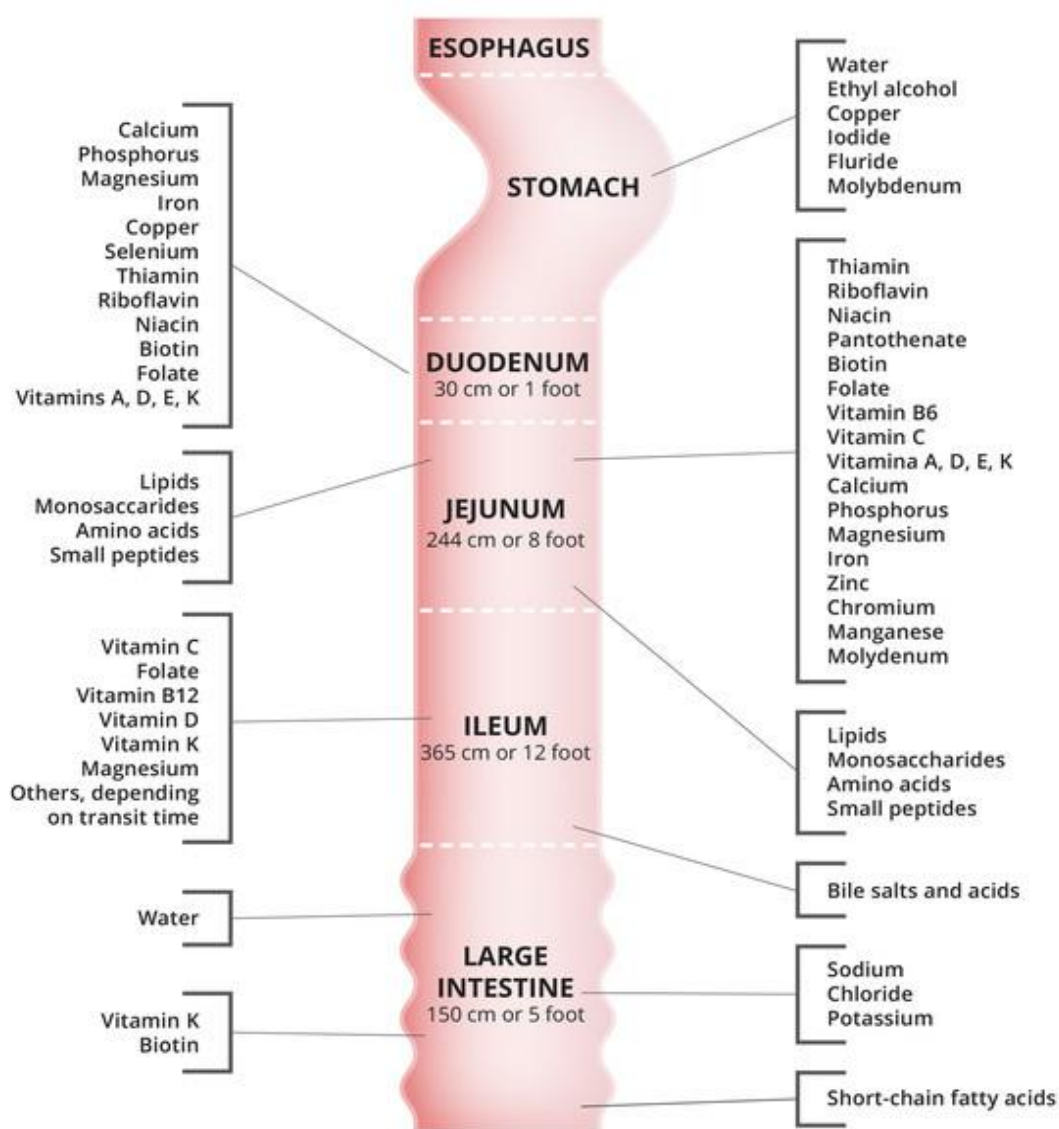
**Gallbladder:** Gallbladder stores extra bile between meals while eating, gallbladder squeezes bile via bile duct into small intestine for action on food.

**Small intestine:** The small intestine consists of pylorus (stomach) to the ileocecal valve (ileum). Small intestine is composed of duodenum, jejunum, and ileum.

**Duodenum:** Average length of duodenum is 30 cm or 1 foot. Acts on by mixing chyme with bile, secretes bicarbonates to increase pH so that to activate pancreatic enzymes which digest the chyme.

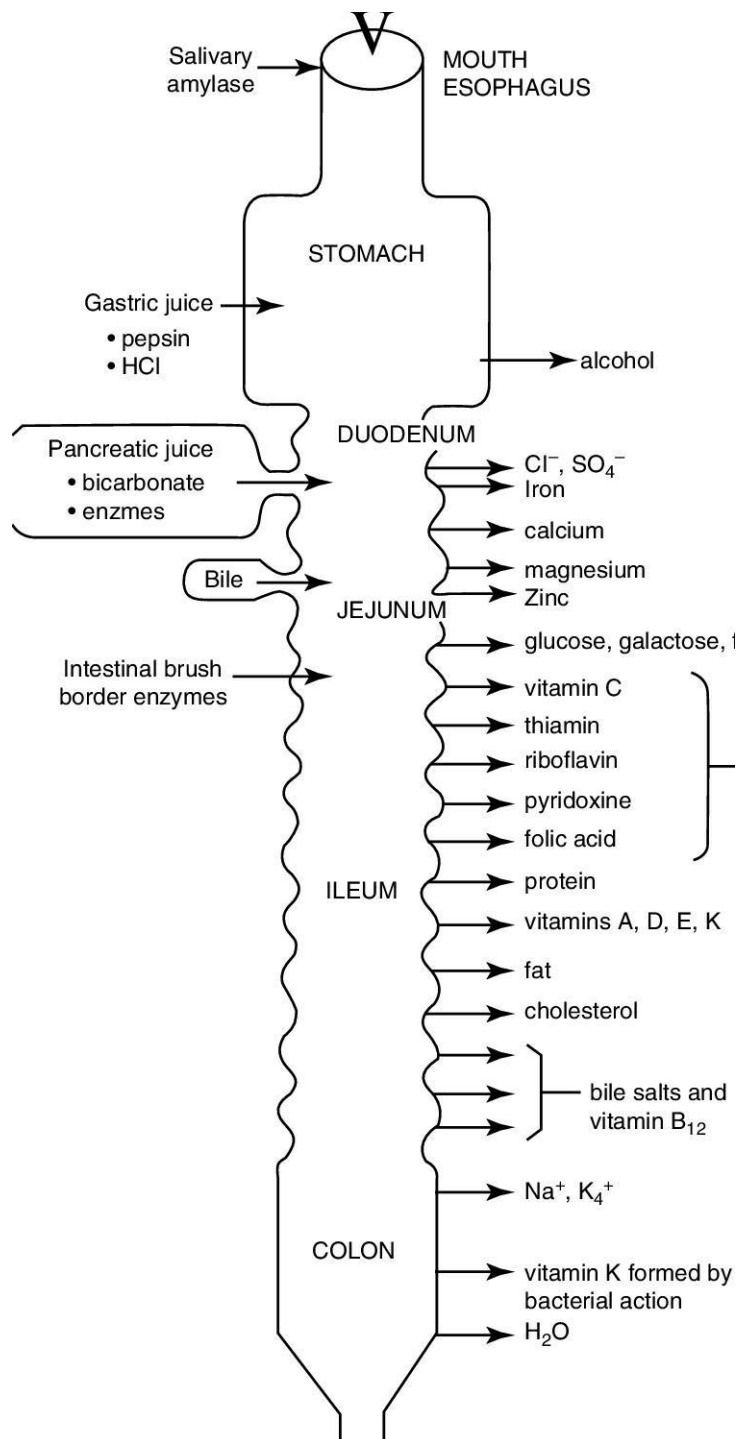
**Jejunum:** In an adult Jejunum measures 244 cm or 8 feet in length. Jejunum absorbs lipids, small peptides, glucose and other small nutrients that have been previously digested in duodenum.

**Ileum:** Approximate size of ileum is 365 cm to 12 feet absorbs vitamin D, K, C and B12, bile salts and all necessary nutrients that were not absorbed in jejunum.



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Note: The duodenum, jejunum and ileum make up the small intestine.



**Cecum:** A pouch that divides small and large intestine connects ileum with ascending colon. Small intestine also produces digestive juice that mixes with bile and pancreatic juice to work and to complete the breakdown of protein, carbohydrate, fat and lipids. Small intestine makes some of the enzymes needed to digest carbohydrates. Small intestine takes water from bloodstream into lower gastrointestinal tract to help digestion of food. It also absorbs water with other nutrients for body requirement. Primarily small intestine works as absorption of vitamins, nutrients, including electrolytes, carbohydrates, iron, proteins, fats and other micronutrients. Most of digestion and absorption of nutrients happens here.

**Large intestine:** In an adult human large intestine is 150cm /5feet. Like small intestine, large intestine also has several segments, according to its physiology, anatomy and functional capacity.

**Ascending colon:** Absorbs water from food and moves into the transverse colon by peristalsis movement.

**Transverse colon:** From hepatic flexure to splenic flexure; absorbs water, salts and electrolytes.

**Descending colon:** From splenic flexure to sigmoid colon; stores fecal feces.

**Sigmoid colon:** Due to the contraction pressure inside the colon, stool moves into the rectum.

In large intestine, more water gets absorbed and further utilised into the bloodstream. Bacteria in large intestine help break down remaining nutrients and make vitamin K. Waste products from action of digestion, absorption including bigger molecules of food that are still too large to get utilised become stool.

**Rectum:** – It holds the formed feces waiting to eliminate when feeling of defecation.

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## 11.4 GASTROINTESTINAL ENZYMES

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Gastrointestinal enzymes are biological catalysts that facilitate the breakdown of food into simpler, absorbable molecules, enabling the body to obtain energy and essential nutrients. They are secreted by different organs, including the salivary glands, stomach, pancreas, and small intestine which play specific role in digesting carbohydrates, proteins and fats.

### 1. Salivary Enzymes

Digestion begins in the mouth, where saliva contains enzymes that start breaking down carbohydrates:

- **Amylase (Ptyalin):**

This enzyme is secreted by the salivary glands and acts on starches, breaking them down into maltose (a disaccharide). Its activity is short-lived as it is deactivated in the acidic environment of the stomach.

### 2. Gastric Enzymes

The stomach secretes enzymes that initiate protein digestion and contribute slightly to fat digestion:

- **Pepsin:**

Pepsinogen, an inactive precursor secreted by gastric glands, is activated by hydrochloric acid into pepsin. Pepsin breaks down proteins into smaller peptides. It functions optimally in the stomach's acidic environment (pH 1.5–2.5).

- **Lipase:**

Gastric lipase helps digest a small amount of dietary fats, converting triglycerides into glycerol and free fatty acids. Its activity is limited compared to pancreatic lipase.

- **Rennin (in infants):**

Found predominantly in infants, rennin helps coagulate milk proteins, making it easier to digest.

### 3. Pancreatic Enzymes

The pancreas is the primary source of digestive enzymes, secreted into the small intestine:

- **Amylase:**

Pancreatic amylase continues carbohydrate digestion by breaking down starches into maltose.

- **Lipase:**  
This enzyme efficiently digests triglycerides into glycerol and free fatty acids, assisted by bile salts that emulsify fats to increase surface area for enzyme action.
- **Proteases:**
  - **Trypsin** and **Chymotrypsin:** Secreted as inactive forms (trypsinogen and chymotrypsinogen), these enzymes are activated in the small intestine. They cleave proteins into smaller peptides.
  - **Carboxypeptidase:** Breaks down peptides into individual amino acids by cleaving terminal amino acids.

#### 4. Intestinal Enzymes

The small intestine produces enzymes that complete digestion, breaking down complex molecules into their simplest forms:

- **Disaccharidases:**
  - **Maltase:** Breaks down maltose into two glucose molecules.
  - **Lactase:** Converts lactose (milk sugar) into glucose and galactose. Lactase deficiency leads to lactose intolerance.
  - **Sucrase:** Splits sucrose into glucose and fructose.
- **Peptidases:**  
These enzymes break small peptides into individual amino acids for absorption.
- **Enterokinase (also called Enteropeptidase):**  
Activates trypsinogen into trypsin, which in turn activates other pancreatic proteases, ensuring efficient protein digestion.

#### Role in Digestion

1. **Carbohydrate Digestion:**  
Begins in the mouth (salivary amylase), continues in the small intestine with pancreatic amylase, and is completed by intestinal disaccharidases like maltase, lactase, and sucrase.
2. **Protein Digestion:**  
Initiated in the stomach (pepsin), it progresses in the small intestine with the action of pancreatic proteases (trypsin, chymotrypsin) and is completed by peptidases.
3. **Fat Digestion:**  
Limited activity occurs in the stomach (gastric lipase), but most of fat digestion happens in the small intestine due to pancreatic lipase, aided by bile from the liver for fat emulsification.

#### Clinical Importance

Deficiencies or dysfunctions in GI enzymes can lead to malabsorption and related disorders:

- **Lactase deficiency:** Causes lactose intolerance, leading to bloating and diarrhea after consuming dairy.
- **Amylase deficiency:** Results in difficulty digesting starches.

- **Protease deficiencies:** Can lead to protein malabsorption, muscle wasting, and reduced immunity.
- **Lipase deficiency:** Causes fat malabsorption, resulting in steatorrhea (fatty stools) and deficiencies of fat-soluble vitamins (A, D, E, and K).

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## 1.5 DISEASE SPECIFIC NUTRITIONAL DIETARY MANAGEMENT

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### 11.6. DIARRHOEA

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Feeling of defecation to eliminate wastes out of body is a normal GI function but when this urge changes and one has more frequent episodes of loose to watery stool, is called diarrhoea. This is common condition and usually resolves without intervention but when it lasts for more than 3-4 episodes for more than 3 days it needs medical attention. Diarrhoea can present alone or can be associated with other symptoms, like abdominal pain, discomfort, nausea, vomiting and cramps, loss of appetite and weight loss.

Diarrhoea is short-lived GI condition, lasting no more than a few days. When diarrhoea lasts beyond 2 or more days into weeks, this indicates it is because of another associated issue — like irritable bowel syndrome (IBS) or some more serious disorder, may be persistent infection, celiac disease / gluten enteropathy or inflammatory bowel disease (IBD) like ulcerative colitis or Crohn's disease.

The most serious risk caused by diarrhoea is dehydration. During a single episode of diarrhoea, water and electrolytes like sodium, chloride, potassium and bicarbonate are lost through watery stools, vomiting, fever, sweat, urination and breathing. Person suffering from diarrhoea can be severely dehydrated where losses are not replaced appropriately. In addition, diarrhoea is a major cause of malnutrition in children, pregnant women and elderly, this makes the person more susceptible in future bouts of diarrhoea and to other infectious diseases.

#### 11.6.1 ETIOLOGY OF DIARRHOEA

Common cause of most self-limited diarrhoea is usually not known. The common cause of diarrhoea are:

1. Bacteria
2. Virus
3. Other Pathogens like parasitic infections

Indeed, diarrhoea is a common symptom of infections caused by a host of viral, bacterial and parasitic organisms, which are mostly spread by faeces-contaminated water, food and air. Infection can happen to them, when there is shortage of adequate sanitation, hygiene and safe water for drinking and cleaning.

Rotavirus (virus) and **Escherichia coli (bacteria)**, are the two most common etiological agents for moderate-to-severe diarrhoea in low-income groups or in developed countries. Other pathogens which are responsible are **cryptosporidium** and **shigella** species in some reasons-specific etiological patterns also need to be considered.

Other possible causes of diarrhea: Infections by other organisms and pre-formed toxins

1. Foods that upset the digestive system (high osmotic fluids like sugar syrups, laxatives etc.)
2. Intolerances and allergies to certain foods (Lactose intolerance and celiac disease).

3. Medications i.e antibiotics
4. Radiation therapy
5. Other mechanical issues

### **11.6.2 SYMPTOM OF DIARRHOEA**

Signs and symptoms of with diarrhea (loose to watery stools) may include -

- Bloating
- Abdominal cramps or pain
- Nausea
- Vomiting
- Fever
- Mucus in the stool
- Blood in the stool
- Low urine output
- Urgent need to have a bowel movement

### **11.6.3 DIAGNOSIS OF DIARRHOEA**

When diarrhea lasts for more than 4 days or still symptoms persist such as fever or bloody stools, physician may need to find the cause. Gastroenterologist/physician may take information from medical and family history, physical examination, blood tests and stool tests (if diarrhea lasts for more than 2 weeks) to find the cause of diarrhea.

**Diagnostic tools are –**

- Complete blood count test,
- Measurement of electrolytes
- Kidney function tests can help indicate the severity of your diarrhea
- Stool test (clinician might recommend stool test to check if a bacterium or parasites are causing diarrhea)
- Whole abdomen ultrasound
- Hydrogen breathe test etc.

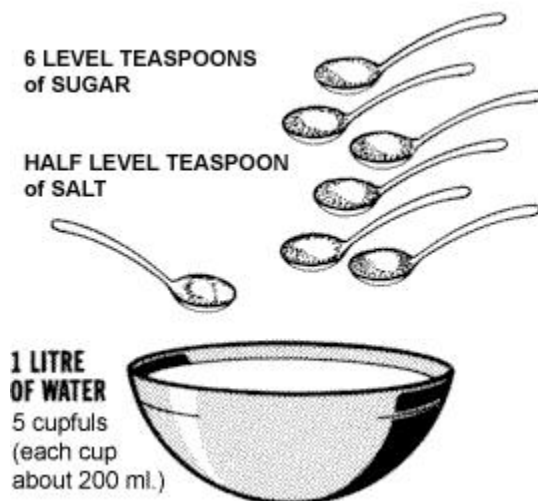
### **11.6.4 PREVENTION OF DIARRHOEA**

Diarrhoea is often caused by infection. Chances of diarrhoea can be stopped or reduce risk by ensuring high standards of hygiene.

1. Washing hands thoroughly with soap and warm water after going to the toilet and before eating or preparing food.
2. Cleaning toilets, toilet handle and the seat, with help of disinfectant after each episode of diarrhoea.
3. Don't share towels, cutlery, utensils, food, with other members.
4. Avoid potentially unsafe water sources and uncooked food when travelling abroad.

Oral rehydration solution formula recommended by World Health Organization (WHO) contains- ORS - millimoles per liter, the following: sodium- 90, Chloride- 80, potassium, glucose- 111 and a base is like as citrate tribasic or bicarbonate-30.

If the diarrhoea happens to infants and children, breast feeding need to be continued for maintaining hydration and by giving plain water.



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## 11.7 CONSTIPATION

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Constipation is a clinical condition in which one may have less than three bowel movements in a week, stools which are hard, dry, and lumpy which are difficult or painful to pass; or a feeling of incomplete evacuation (that not all stool has been passed). Usually, constipation can be prevented by lifestyle and dietary changes.

**Types of constipation:** There are three main types of functional constipation.

1. **Normal-transit constipation-** Most common type of constipation and is caused by dysfunction of muscles and nerves that are responsible for bowel movements.
2. **Slow-transit constipation -** Caused by the way food moves through the intestines to the colon nerves aren't properly signaling colon muscles to move the way they should do.
3. **Pelvic floor dysfunction -** When the muscles involved in anus and rectum are too weak or too tight to allow the regular bowel movements.

### 11.7.1 SYMPTOM OF CONSTIPATION

The definition of constipation itself says about the classic symptoms of chronic constipation which are less than three bowel movements a week.

1. Hard, dry or lumpy stools
2. Stools are difficult or painful to pass
3. Feeling of incomplete evacuation that all stool has not passed.
4. Other symptoms are
  - bleeding from your rectum

- blood in your stool
- constant abdominal pain
- inability in passing gas
- distended abdomen
- loss of appetite
- vomiting
- lower back pain
- losing weight

### 11.7.2 ETIOLOGY OF CONSTIPATION

Constipation can appear when life or daily routine changes. For example, bowel habits can change

- Change in overall dietary habits
- Reduced intake of dietary fibre
- Reduced fluids intake
- Less physical activity
- High intake of simple and refined carbohydrate
- Pregnancy
- Old age
- Travelling
- Ignoring the urge for a bowel movement
- Medicines

**Certain other associated health and nutrition problems can cause constipation:**

- Sedentary lifestyle
- Dehydration
- Celiac disease
- Brain and spine disorders, such as Parkinson's disease
- Brain or spinal cord injuries
- Metabolic diseases, such as diabetes
- Hormonal imbalance, such as hypothyroidism
- Inflammatory diseases or proctitis, intestinal obstructions, anorectal blockage, tumors etc.

### 11.7.3 TREATMENT AND DIETARY MANAGEMENT OF CONSTIPATION

Increasing enough dietary fibre and drink plenty of liquids to help fiber work better.

**Fiber: Depending on age and sex, adults should get 25-30 grams of fiber per day or per 1000 kcal diet, 14gms of fiber is recommended to avoid constipation.**

Make sure to add fiber in diet a little at a time so body gets used to the change and can digest well without any problem like bloating, distension etc.

**Sources of fiber:** Whole grains and products, whole pulses and legumes, fresh fruits and berries, fruits with skin specially apple, pears and orange, vegetables, broccoli, green peas, green leafy vegetables, grains like roasted gram, corn, beans etc

- legumes such as lentils, kidney beans, soybeans and chickpeas as whole.
- Fruits - berries, apples with the skin, oranges, pears etc.
- Vegetables - carrots, broccoli, green peas, and collard greens, green leafy vegetables etc.
- nuts, such as almonds, peanuts, and pecans, others food and products such as whole-grain breads and cereals, dried fruits, wheat bran, wheat germ, fresh fruits and vegetables including the skin on potatoes, dried beans and peas, oats, barley, brown rice last but not least plenty of water.

Drinking water and other liquids throughout a day such as fresh fruit and vegetable juices and clear soups, so that the fiber work better. This change will make stool soft and easy to pass.

Drinking plenty of water and other liquids is also a good idea to avoid dehydration. Maintaining hydration is good for overall health and can help avoid getting constipated.

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## 11.8 PEPTIC ULCER

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What are peptic ulcers: Peptic ulcer is a type of sore that develops on the inner lining of the stomach or duodenum and the upper part of the small intestine just below the stomach. In some cases, peptic ulcer may develop just above stomach, in esophagus.

### 11.8.1 SYMPTOMS OF PEPTIC ULCER

Anyone can develop a peptic ulcer, and the most common symptom is burning sensation, abdominal pain, loss of appetite and indigestion. Peptic ulcer symptoms may vary in person to person depending upon the cause. The excess acid production can lead to varying symptoms such as diarrhoea, abdominal pain, acid reflux, nausea, vomiting, and decreased appetite.

The typical abdominal pain can occur anywhere from navel up to your breastbone, and may follow any of these patterns as symptoms -

1. Feels worse when stomach is empty
2. Feels better temporarily while eating or take an antacid
3. Gets worse at night in lying down position
4. Comes and goes for days or weeks

Peptic ulcers may be caused by a bacterial infection, certain drugs, or rare tumors.

### 11.8.2 TYPES OF PEPTIC ULCER

The common kinds of peptic ulcers are based on the location where they occur and affect organ part.

1. **Esophageal Ulcers:** These occur inside the esophagus, the tube that carries food from throat to stomach.

2. **Gastric Ulcers:** Most common type of ulcer, occur inside the stomach.

3. **Duodenal Ulcers:** This type of ulcer is located in the upper part of the small intestine, called the duodenum.

### 11.8.3 ETIOLOGY OF PEPTIC ULCER

It was thought that spicy foods or stress can cause peptic ulcers which gets worse after consuming

spicy and oily food but the exact reason responsible for this condition is unknown.

In fact, the most common causes of ulcers are:

- Use of nonsteroidal anti-inflammatory drugs, such as aspirin, advil or mortrin, and aleve which can damage the inner lining of the digestive tract.
- *Helicobacter pylori*, a type of bacteria that can infect stomach.

Certain factors may put at greater risk of developing a peptic ulcer, including:

1. Taking high doses of NSAIDs (pain killers)
2. Taking NSAIDs regularly for long period of time
3. Steroidal treatment for immunity related diseases can cause peptic ulcers.
4. Being female
5. Being 70 years or older
6. Smoking and drinking alcohol
7. Having a history of peptic ulcers

Other rare causes of peptic ulcers may include serious illness, surgery, or medications other than NSAIDs.

Many people with peptic ulcers don't have any signs or symptoms. If they do, however, upper abdominal pain is the most common one.

The abdominal pain can occur anywhere from navel upto breastbone, and it may follow any of these patterns:

8. Feels worse when stomach is empty
9. Feels better temporarily after eating or taking an antacid
10. Gets worse at night
11. Comes and goes for days or weeks

Less commonly, a severe or complicated peptic ulcer may cause the following symptoms:

4. Nausea or vomiting
  5. Vomiting red or dark blood
  6. Bloody, black, or tar-like stools
  7. Unexplained weight loss
  8. Changes in your appetite
  9. Difficulty breathing
  10. Feeling faint or weak
- Being female
  - Being 70 or older
  - Smoking
  - Drinking alcohol
  - Having a history of peptic ulcers

### 11.8.4 DIAGNOSIS OF PEPTIC ULCER

If doctor suspects that one may have peptic ulcer, the next steps include taking a detailed full medical history and performing a physical examination. The clinician may also order the following diagnostic tests:

1. Lab Test - tool test or a breath test may be performed to determine whether *H. pylori* bacteria are present.
2. Endoscopy - A hollow tube with camera will be passed down throat to esophagus, stomach, and small intestine. It allows doctor to look for a peptic ulcer and take a biopsy (tissue sample) if one is present.
3. Swallowing barium: For this test, patients swallow a white liquid containing barium, which coats digestive tract to make ulcers more visible in a series of X-rays of upper digestive tract.

### 11.8.5 TREATMENT AND DIETARY MANAGEMENT OF PEPTIC ULCER

Course of treatment will be based on the cause of peptic ulcer. Treatment involves taking acid-suppressing medications to kill *H. pylori* bacteria, if present, to promote healing, and stopping any medications that are causing peptic ulcer. Patients may also experience symptom relief from certain lifestyle measures and dietary interventions.

Certain dietary and lifestyle changes may help recover from a peptic ulcer:

1. **Diet:** find out that there are specific foods that make ulcer feel worse, avoid them until treatment is over. For example, those include alcohol, caffeine, fatty foods, spicy foods, chocolate etc.
2. **Stop smoking:** Ulcers take longer to heal, and medications for ulcer treatment may be less effective, if smoking is continued.
3. **Use pain medications with caution:** talk to doctor before taking any of medications; they may continue putting on anta-acid drug to prevent ulcer recurrences.

#### Dietary Fibre & Vitamin A:

Research shows that a high fibre diet reduces the risk of developing ulcers. As there is a stronger association between diets high in soluble fibre and a decreased risk for developing ulcers.

Foods rich in soluble fibre include legumes, oats, flax seeds, barley, nut and berries, certain vegetables and fruits like oranges, apples, carrots etc.

A diet rich in vitamin A from all sources might reduce the development of duodenal ulcer, as diets high in fruits and vegetables, possibly reduce ulcers due to their fibre content.

**Green Tea and Flavonoid-Rich Foods:** -Black tea indicated, these teas inhibit the growth of *H. pylori* but cause no harm to beneficial types of bacteria

Flavonoid-rich foods include garlic, onions, and colourful fruits and vegetables such as cranberries, strawberries, blueberries, broccoli, carrots, and peas.

#### Assess your individual tolerance:

No evidence suggests that eating spicy, oily or citrus foods affect ulcer formation, although individuals find and report worsening of symptoms after eating these foods. It is important to find out what works for individual. If one notices that symptoms get worse after eating some specific type of foods, then limit or avoid them so can feel better, making sure that don't eliminate an entire food group.

## Conclusion

In summary, if one suffers from peptic ulcer, the aim is to have a diet high in fibre and rich in vegetables, fruits, and whole grains. Try for minimum of five to seven servings of vegetables and fruits each day, and a minimum of three to five servings of whole grains. Choose foods which are good source of soluble fibre, vitamin A, and flavonoids.

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## 11.9 FLATULENCE

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It is normal phenomenon that everyone passes gas through belching or farting.

Flatulence (also called farting and passing wind), is the passing of gas out of the back passage (rectum/anus) from the digestive system.

Passing wind is normal process for everyone, till its odourless and limited between 5-15 times a day. When this tendency and frequency and foul-smelling flatulence can be socially embarrassing, especially so in a crowded elevator or at an important meeting then need to take some measures for controlling and avoiding it.

Sometimes intestinal gas causes some gas pain or bloating. Most of the time people find gas relief with dietary changes and over-the-counter drugs.

### 11.9.1 SYMPTOM OF FLATULENCE

**Symptoms of excessive flatulence are**

1. Passing wind very frequently
2. Smelly and loud passing of wind
3. Abdominal discomfort due to distension
4. Rumbling of lower abdomen

### 11.9.2 ETIOLOGY OF FLATULENCE

The gas is produced in digestive system by different means, like swallowed air along with swallowing food and drinks or saliva.

Chewing food very fast

Swallowing big chunks of food

Chewing gum habit

Smoking and sitting for long

Sucking on like pencils, pen tops, or hard candies

Wearing dentures that are loose-fitting etc

### ***Digestion and intestinal fermentation:***

Gases are produced in digestive tract as side product of digestion and fermentation and are pushed along the bowel.

### **Food and drink:**

Foods that contain unabsorbable carbohydrates, like high-fibre diets, carbonated drinks, artificial sweeteners, some pungent vegetables (beans, peas, garlic, cabbage, onions and broccoli), fruits (apple, apricot and pear) and dry fruits like raisins and fructose-containing fruit juices may cause high gas formation and flatulence.

### 11.9.3 TREATMENT AND DIETARY MANAGEMENT

Flatulence can be prevented and treated by making changes to diet and lifestyle.

#### Diet Management

1. Reduce use of dairy and products: low-lactose dairy foods, such as yoghurt, instead of milk.
2. Observe and avoid flatulence-causing foods from daily routine like pungent foods and meats, onion, garlic, beans, broccoli, cabbage, artificial sugars etc.
3. Reduce intake of fried foods and carbonated drinks.
4. Temporarily reduce the intake of high-fibre food that takes too much time to digest.

#### Lifestyle changes

5. Try small portions of healthy and balance diet.
6. Eat slow and chew food thoroughly, and do not gulp directly
7. Avoid chewing gum, hard candies, and drinking through a straw
8. Dentures need be firm and well set
9. Quit smoking
10. Avoid long sitting hours
11. Regular physical exercise
12. Dietary supplements: Supplements may help improve the digestion and prevent flatulence.
13. Probiotics encourage the growth of friendly bacteria in the digestive system, which help in digestion and reduce flatulence.

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## 11.10 LET US SUM UP

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The gastrointestinal system is essential for digestion, nutrient absorption, and waste elimination, but disturbances like diarrhea, constipation, peptic ulcers, and flatulence can impair these functions. Diarrhea requires rehydration and a low-residue diet, while constipation is managed with high fiber intake, hydration, and physical activity. Peptic ulcers necessitate avoiding irritants like spicy foods and alcohol, alongside small, frequent meals to soothe the stomach lining. Flatulence management involves identifying triggers, avoiding gas-producing foods, and incorporating probiotics. By understanding these conditions and following appropriate dietary and lifestyle strategies, we can effectively prevent and manage GI disturbances, ensuring better digestive health and overall well-being.

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## 11.11 CHECK YOUR PROGRESS

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### Short Questions

1. What is the role of enzymes in the digestive system?
2. Name two common symptoms of diarrhea.
3. Define peptic ulcer in one sentence.
4. List two dietary recommendations for managing constipation.
5. What is flatulence, and what causes it?

## **Long Questions**

1. Explain the structure and functions of the digestive system and the role of enzymes in digestion.
2. Discuss the etiology, symptoms, and dietary management of diarrhea.
3. Describe the causes, prevention, and dietary treatment of constipation.
4. Analyze the dietary and lifestyle modifications required for managing peptic ulcers.
5. Elaborate on the causes, symptoms, and nutritional approaches to manage flatulence.

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## UNIT-12 : NUTRITION IN CARDIOVASCULAR DISEASES

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### Strucure

- 12.1 Introduction
- 12.2 Structure of heart
- 12.3 Function of heart
- 12.4 Etiology of Cardiovascular diseases
- 12.5 Prevention of Cardiovascular diseases
- 12.6 Atherosclerosis
  - 12.6.1 Etiology of Atherosclerosis
  - 12.6.2 Symptoms of Atherosclerosis
  - 12.6.3 Diagnosis of Atherosclerosis
  - 12.6.4 Prevention of Atherosclerosis
  - 12.6.5 Treatment of Atherosclerosis
  - 12.6.6 Dietary Management of Atherosclerosis
- 12.7 Hypertension
  - 12.7.1 Prevalence of HTN
  - 12.7.2 Symptoms of HTN
  - 12.7.3 Consequences of HTN
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- 12.8 Congestive Heart Diseases and Heart Failure
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  - 12.8.3 Symptoms of Chronic Heart Failure
  - 12.8.4 Nutritional Management of Chronic Heart Failure
- 12.9 Let Us Sum Up
- 12.10 Check Your Progress

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### 12.1 INTRODUCTION

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Cardiovascular diseases (CVDs), encompassing conditions such as coronary artery disease, hypertension, heart failure, and stroke, remain a leading cause of morbidity and mortality worldwide. These disorders are often linked to modifiable lifestyle factors, including poor dietary habits, physical inactivity, and tobacco use, as well as non-modifiable risk factors like genetics and age. Nutrition plays a pivotal role in both the prevention and management of CVDs, influencing key risk factors such as cholesterol levels, blood pressure, inflammation, and body weight. Diets rich in heart-healthy nutrients, such as omega-3 fatty acids, fiber, antioxidants, and potassium, are known to

reduce cardiovascular risks, while excessive intake of saturated fats, trans fats, sodium, and added sugars can exacerbate disease progression. Specific dietary patterns, including the Mediterranean diet and DASH (Dietary Approaches to Stop Hypertension) diet, have demonstrated significant benefits in improving cardiovascular health. This chapter explores the critical role of nutrition in cardiovascular disease, focusing on evidence-based dietary strategies to reduce risk factors, improve cardiac function, and enhance overall cardiovascular outcomes for individuals across various stages of the disease spectrum.

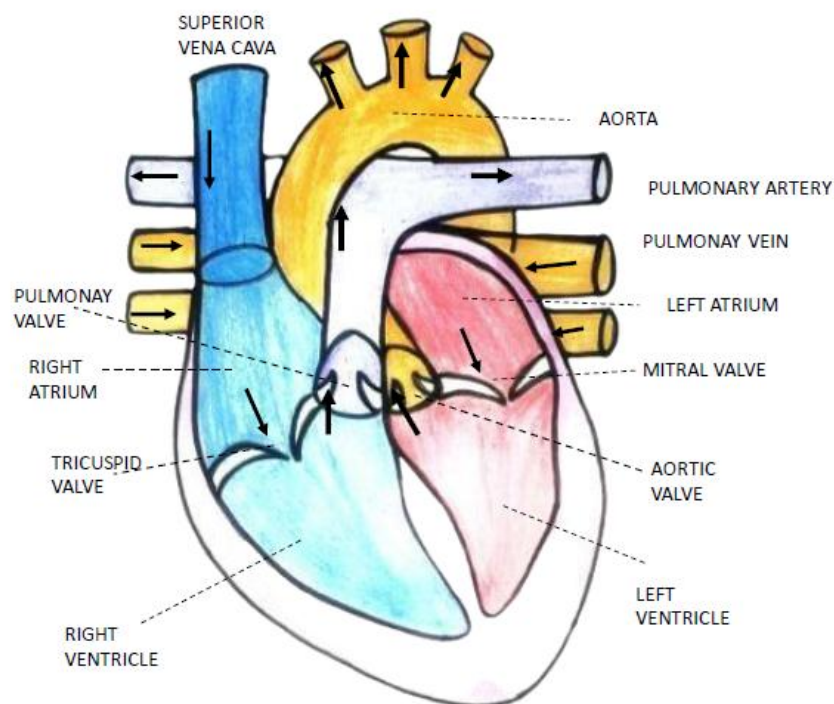
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## 12.2 STRUCTURE OF HEART

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Heart (size of a clasped fist) is a muscular organ located in chest cavity in between the two lungs. It is placed slightly slanted towards the left in the thoracic region. It is encased by the fluid-filled cavity known as pericardium. The heart wall consists of three layers: Epicardium (outermost layer), Myocardium (middle layer) and the Endocardium (innermost layer).

The heart comprises of four chambers: Two upper chambers include the left and the right atria while two lower chambers include right and left ventricles. The right and the left region of the heart are separated by a wall of muscle called the septum. The ventricles are the chambers that pump blood and atrium are the chambers that receive the blood. The structure of the heart also houses the biggest artery in the body – **the aorta**. The heart pumps blood through a set of connections between arteries and veins through the cardiovascular (or the circulatory) system. The blood vessels comprise of veins which supplies deoxygenated blood to the heart via inferior and superior vena cava into the right atrium. Capillaries are tiny, tube-like vessel forming a network between the arteries and veins whereas arteries (except pulmonary arteries) are muscular-walled tubes which supply oxygenated blood away from the heart to all parts of the body (except lungs)



**Fig 12.1: Structure of Heart**

## Types of Circulation

Pulmonary circulation is a portion of circulation accountable for carrying deoxygenated blood from the heart to the lungs and then bringing oxygenated blood back to the heart.

Systemic circulation is another portion of circulation where the oxygenated blood is pumped from the heart to every organ and tissue in the body and deoxygenated blood comes back again to the heart.

The right ventricle pumps deoxygenated blood to the lungs via pulmonary arteries and pulmonary trunk. The left ventricle pumps newly oxygenated blood to body via aorta. The heart valves act as doors between chambers of the heart and they open and close to allow the blood to flow through. The important valves are:

| <b>Tricuspid valve:<br/>Atrioventricular valve (AV)</b>                                                                                                                                                                                                                                                                                                                                   | <b>Pulmonary valve</b>                                                                                                                                                                                                                                                                                                                       | <b>Mitral valve</b>                                                                                                                                                                                                           | <b>Aortic valve</b>                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>It has three leaflets or cusp and it is located between right ventricle and right atrium</p> <p>It opens and closes to ensure that blood flows in the correct direction (from right atrium to the right ventricle)</p> <p>When the right ventricle contracts while sending the blood to the lungs, the tricuspid valve closes to avoid the backflow of blood into the right atrium</p> | <p>a semilunar valve looks like a half moon.</p> <p>It is located at the connection between the pulmonary artery and the right ventricle, and the aorta and the left ventricle.</p> <p>When the right ventricle relaxes pulmonary valve prevents back flow of blood that has been expelled into the pulmonary artery into the ventricles</p> | <p>Mitral valve or bicuspid valve (two cusp)</p> <p>Acts as a door between left atrium and left ventricle</p> <p>Blood flows through atrioventricular valve to left ventricle and cannot go back up into the left atrium.</p> | <p>Aortic valve: a semilunar valve located between the left ventricle and the aorta</p> <p>Blood leaves the left ventricle through this valve and cannot return</p> |

Succeeding the blood flow into the ventricle from the atrium, the AV valve snaps shut making the first heart sound (“lub”) of the heartbeat and the “dub” sound is caused by the closing of Semilunar valves

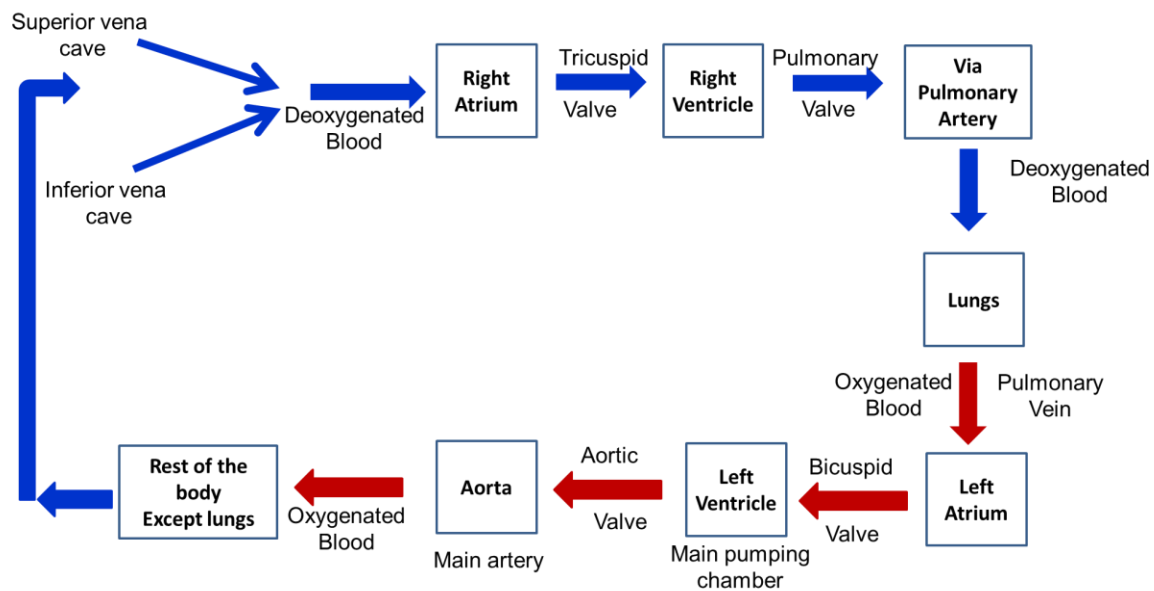


Fig 12.2 a : Circulatory system

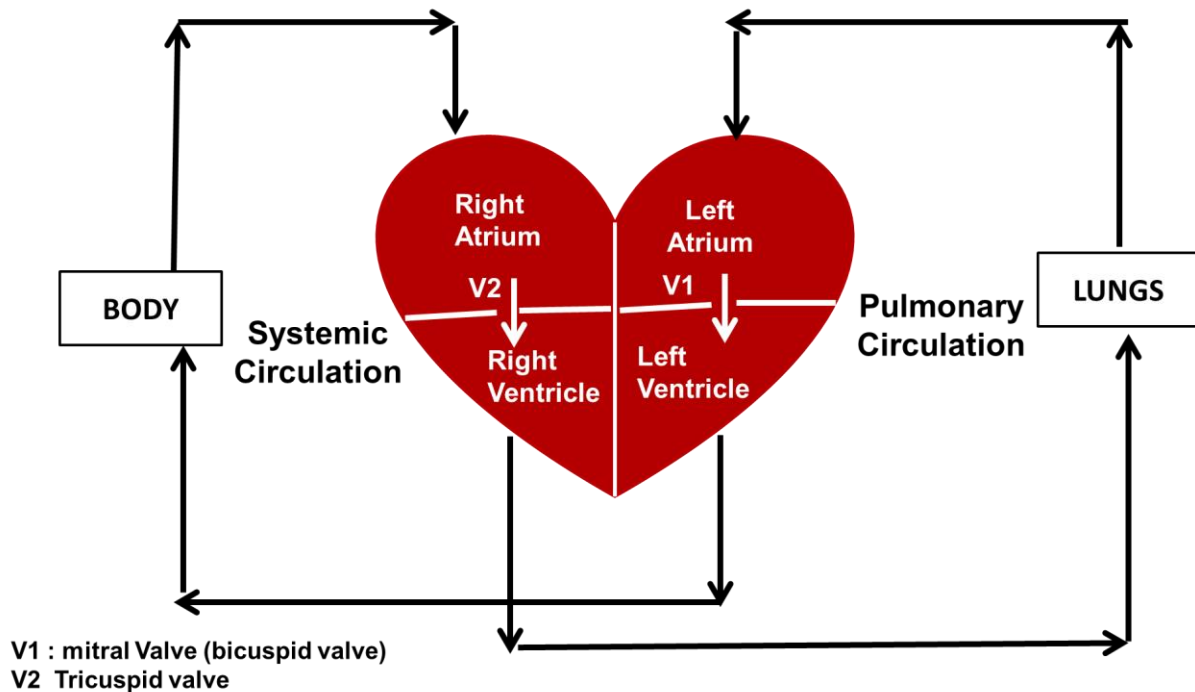


Fig 12.2 b : Circulatory system

## 12.3 FUNCTION OF HEART

The crucial function of the heart is to maintain a constant flow of blood throughout the body via cardiovascular or circulatory system. The circulatory system plays a vital role not only in supplying oxygen and important nutrients but also removing the carbon dioxide and other wastes from the body. The heart also safeguards that acceptable level of blood pressure is maintained in the body.

**Diagnosis of CVD:** Early diagnosis of cardiovascular disease is crucial for prompt appropriate intervention and treatment. It also helps in improving the clinical outcomes, saving lives and help the

at-risk patients to adopt a healthy lifestyle and following a well-balanced diet for minimizing the risk of a heart disease. Besides blood tests and a chest X-ray, many important diagnostic tests are used to diagnose cardiovascular disease. Various diagnostic markers may include:

**ELECTROCARDIOGRAM (ECG):** It is a most simple, quick, painless and important test frequently used for basic cardiac assessment. It provides the useful information regarding previous damage to the cardiac muscles, enlargement of heart chambers and abnormalities in the electrical system of the heart.

**Holter monitoring.** It is a portable ECG device that records the heart's activity during daily activities for a day or more and helps in detecting irregular heartbeats that may be missed through a regular ECG

**TREADMILL TEST (TMT):** it records the ECG while walking on a treadmill machine to assesses the response of the heart to increased workload and demand for blood.

**ECHOCARDIOGRAM (Echo):** This is a **non-invasive** test done using high frequency sound waves (ultrasound) to take images and measurements of different parts of the heart including the heart valves.

**TRANSESOPHAGEAL ECHOCARDIOGRAM (TOE):** It is a diagnostic procedure in which a tube with a tiny ultrasound probe is inserted through the patient's mouth and pictures of the heart are obtained using sound waves.

**HEAD-UP TILT TABLE TEST:** This test is done to identify the cause for dizziness or episodic loss of consciousness with unknown etiology. During the test, patient is tilted head up to a certain angle for up to 45 minutes, while heart rate, ECG and blood pressure is continuously monitored. Any change in heart rate, blood pressure or recurrence of symptoms is carefully observed.

**Coronary angiography:** It is done to assess the function of the cardiac muscles, heart valves and coronary arteries. A catheter is inserted into an artery and sometimes a vein, in the groin or wrist and guided to the heart (using a dye) to detect the blockages in the coronary arteries.

**Blood tests and cardiac biomarkers:** lipid Profile, lipoprotein (a), homocysteine, Troponin I, CK-MB, pro BNP, myoglobin etc

**Cardiovascular diseases (CVD)** are defined as all the diseases associated with the heart and / or the blood vessels or in other words it is a broad term comprising of a spectrum of diseases associated with ailments of the circulation, heart muscles or the vessels of the heart.

CVD have become the foremost cause of mortality in India. In comparison with the people of European ancestry, CVD affects Indians at minimum of ten years prior and in their utmost midlife years. According to the Global Burden of Disease study age-standardized estimates (2010), nearly one fourth (24.8%) of all mortality is assignable to CVD in Indians. Prevalence as well as risk factors of CVD is growing fastly placing burden on healthcare systems.

**Types of CVD:** It may include heart attack (myocardial infarction), angina, stroke, hypertension, congestive heart failure and rheumatic heart disease etc.

**Symptoms:** CVD may initially cause no symptoms at all. However, typical symptoms of an underlying cardiovascular issue include: pain or pressure in the chest, which may indicate angina pain or discomfort in the arms, left shoulder, elbows, jaw, or back, shortness of breath, nausea and fatigue, light-headedness or dizziness and cold sweats.

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## 12.4 ETIOLOGY OF CARDIOVASCULAR DISEASES

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Prevalence of cardiovascular diseases is growing rapidly as well as happening at early age. Risk factors for CVD are conventionally classified into modifiable and non-modifiable risk factors. Several studies have recognized that control of modifiable risk factors led to considerable reductions in CVD events.

**Uncontrollable or non-modifiable Risk factors of CVD:** There is no control over these risk factors. Important risk factors include age, gender, race/ethnicity and heredity.

**Controllable or modifiable risk factors of CVD:** The focus should be on modifiable risk factors which have a lesser but still substantial role. These include high blood pressure, dyslipidemias, diabetes, obesity (especially central obesity), low intake of fruits and vegetables, smoking, tobacco chewing, alcohol, stress, sleep disorders, physical inactivity and sedentary lifestyle. Fortunately, most of these modifiable risk factors can be mitigated or controlled through healthy, balanced diet and an optimal lifestyle.

**Goals of dietary management:** The goals of dietary management (alone or in combination with regular physical activity or with lipid lowering drugs) are to maintain ideal body weight, maintain normoglycemia, maintain blood pressure, maintain lipid profile within the target range by consuming a diet high in fresh natural seasonally and locally available vegetables and fruits, low fat milk and low fat dairy products, high in dietary fiber, low in total fat, saturated fat, trans-fat and cholesterol, salt and sodium. The consumption of processed meats, refined carbohydrates and sugar sweetened beverages (SSB) should be curtailed for CVD risk reduction.

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## 12.5 PREVENTION OF CARDIOVASCULAR DISEASES

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Nutritional care has been provided much importance in the modern era. Most important way for prevention and control of cardiovascular diseases is the promotion of a healthy balanced diet with appropriate portion control and encouragement for adopting an optimal healthy lifestyle coupled with regular physical activity throughout the life.

Several epidemiological and clinical studies have observed that a broad array of CVD (including heart diseases, atherosclerosis, arrhythmias, elevated blood pressure, and cardiac mortality) and obesity are often closely associated. Obesity may have an impact on the incidence, development and progression of cardiovascular disease by impacting on body mass, lipid profile, blood pressure and other risk factors of cardiovascular disease.

**Maintaining ideal or desirable body weight:** IBW is the term describing the weight that people are expected to have based on age, sex and height. Several formulas are available for calculating ideal body weight. Hamwi is one of the most important formulas used to calculate IBW.

**Table 12.1: Hamwi formula for calculating Ideal Body weight**

|        |                                                                                        |
|--------|----------------------------------------------------------------------------------------|
| Male   | 48 kg for the first 5 feet (152.4 cm) and 2.7 kg for every inch (2.54 cm) after 5 feet |
| Female | 45 kg for the first 5 feet (152.4 cm) and 2.3 kg for every inch (2.54 cm) after 5 feet |

The weight corresponding to the BMI 21-22.9 may also be considered as ideal body for Indian population.

**Assessment of overweight and obesity:** Overweight and obesity are assessed in a variety of ways. The most commonly simplest and easiest used methods may include

- Body Mass Index (BMI) or Quetelet's Index
- Waist circumference and Waist-to-hip ratio (WHR)

**1. Body Mass Index (BMI)** also known as Quetelet's index is a very simple, useful and easy to use method for estimating the body fatness and gives a more accurate measure of total body fat compared to the assessment of body weight only. BMI can be calculated using the formula:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

BMI should not be used as the only method for assessing overweight / obesity. The best option is to combine the BMI with simplest measurements like waist circumference for accurate assessment of adiposity. BMI varying between 18.5 and 25 is considered as normal. Though, for Asians Indians it is recommended to maintain the BMI between 18.5 and 23. Indian population is often associated with higher percentage of body fat even at lower BMI as compared to Caucasians and Europeans, they are at higher risk of non-communicable diseases.

**2. Waist to Hip Ratio (WHR):** Assessment of abdominal fat mass is very crucial. Individuals having similar BMI and total body fat may have dissimilar abdominal fat mass. The WHR (waist circumference divided by hip circumference) is the simple and easy method to differentiate between fatness in the lower trunk (hip and buttocks) and fatness in the upper trunk (waist and abdominal area).

The dissemination of fat around the belly is nowadays considered to be more harmful as compared to the fat distribution around the hips. Higher waist circumference is reflected as an important risk factor. The waist circumference and waist-to-hip ratios are beneficial for the assessing central and truncal obesity respectively. Fat around the waist is recognized as central obesity and considered as a traditional risk factor for development of CVD. Recommendation suggests keeping the waist circumference less than 90 cm for males and below 80 cm for females.

**Waist to Hip ratio (WHR):** The WHR is obtained by waist circumference divided by hip circumference and is a simplest measure for discriminate between body fatness in the upper and lower trunk.

**Table 12.2: cut off points for waist circumference and WHR**

|        | Caucasian                |         | Asian-pacific            |         |      |         |
|--------|--------------------------|---------|--------------------------|---------|------|---------|
|        | waist circumference (cm) |         | waist circumference (cm) |         | WHR  |         |
|        |                          | At risk |                          | At risk |      | At risk |
| Male   | <102                     | >102    | <90                      | >90     | <0.9 | >0.9    |
| Female | <88                      | >88     | <80                      | >80     | <0.8 | >0.8    |

**Energy Intake:** The recommended energy should be adequate enough to maintain ideal body weight. A balanced, healthy diversified diet with judicious choices (with appropriate portion control) rich in

dietary fibers, including low glycemic index foods, adequate in proteins, vitamins, minerals and healthy fat (permitted amount) is vital for maintaining health. The important strategy for weight reduction in overweight and obese patients is to create a negative calorie balance while maintaining proper balance of all the micro nutrients through planning an appropriate caloric restriction with proper portion control. Carbohydrate, fat and protein are the foremost sources of energy. Simple sugars are unhealthy and should not contribute to more than 10% of total energy while choosing a wide variety of complex carbohydrate from whole grains cereals, millets, legumes and vegetables etc.

**Dietary Protein Intake:** Protein is one of the most important macronutrients affecting the cardiovascular disease and seems to be inversely associated with it. Quality of protein has more pronounced effect on serum lipoproteins as compared to the quantity of protein. Replacing saturated fatty acids or carbohydrate by proteins has valuable effects on risk factors especially on serum TG, serum LDL level and systolic BP. Vegetable proteins are also rich in dietary fibers, low in saturated fat and are devoid of trans fat and cholesterol. Protein sources like nuts, soya, pulses, legumes and animal source are rich in L-arginine which improves endothelial dysfunction. Consumption of low fat dairy proteins is useful. In case of non-veg eaters' egg, lean meats, skim milk and skim milk products should be preferred.

Low fat milk and milk products like yogurt, mattha / chaach, whey water, hung curd, low fat paneer, eggs, lean meat, fish and chicken are good quality protein whereas beans (green and dry) pulses, legumes, nuts, soya (beans, chunks and granules), mix sprouts are also rich in protein. Vegetarian people can combine two or more vegetarian protein in their diet to improve the protein quality via mutual complementation of various amino acid in different vegetarian proteins.

**Carbohydrates (carbs) and CVD:** Carbohydrate is an important constituent of Indian diet. It contributes to the major proportion of total daily energy intake in the diet. Complex carbohydrates and simple carbohydrates are two main types of carbohydrates. They differ in terms of how rapidly they are digested and absorbed in the gut. It is indispensable to know the difference between the good (or complex carbs) versus bad carbs (or simple/refined/processed carbs). Majority of carbs consumption must be from complex carbs as they are rich in dietary fiber, vitamins and minerals, low in glycemic Index, give satiety on lesser calories, absorbed gradually. Complex carbs are also a good source of dietary fibers, B-complex vitamins, zinc, selenium, phosphorus, folate, magnesium, calcium, iron, potassium, and antioxidants. They help to maintain body weight; blood sugar and blood pressure therefore lower the CV risk factors.

The dietary intake from simple / refined / processed carbs should be limited or restricted as they are energy dense, nutrients poor, low in dietary fiber, minerals, vitamins, have high glycemic index, high glycemic load, digested and absorbed more rapidly hence contribute to weight gain. Substituting these food items with low glycemic index and high fiber foods are important strategy. Sugar sweetened beverages; various carbonated and aerated drinks should be avoided. The food plate should be as colourful and healthier as possible by including a variety of fresh, seasonal and local fruits and vegetables (rich in vitamins, minerals, phytochemicals and antioxidants). Insulin resistance and simple carbohydrates are the driving influences for cardiac disease.

A carbohydrate intake of more than 60% of calorie seems to be associated with higher total and non CVD death. Several studies have reported that a diet high in carbs seems to reduce serum HDL cholesterol levels and upsurge the triglyceride to HDL ratio and the fraction of small LDL contributing to the metabolic syndrome. A diet high in carbohydrate together with high glycemic index foods may contribute to escalation of the risk of CVD. The quantity as well as the quality of carbohydrates has to be selected wisely for prevention and control of cardiovascular disease.

**Dietary Fat:** All fats are concentrated sources of energy (1 g = 9 Kcal) and must be consumed in moderate amount. A small amount of fat is present in almost every food item known as invisible fat. There are hidden fat present in the processed and ready-to-eat foods items. The fat in the vegetable oil, desi ghee, and vanaspati used for cooking and preparation of meals contain visible fat. The visible, invisible and hidden fat all together contributes to the total dietary fat intake in the Indian diet. Choosing the amount and quality of fat sensibly is crucial for cardio protective effect.

For CVD prevention, the fat composition of diet is more important than total fat content alone. Using a variety of fats and oils, nuts and seeds in the diet ensures that all the types of fatty acids are consumed and all essential fatty acids are met in the diet. Depending on chemical structure fats are classified into saturated fatty acids and unsaturated fatty acids (monounsaturated fatty acids and polyunsaturated fatty acids)

| Saturated Fat                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Polyunsaturated Fat                                                                                                                                                                                | Monounsaturated Fat                                                                                                                                                                                                                                            | Trans Fat                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Solid at room temperature</p> <p>Increase levels of total cholesterol and LDL, decrease HDL</p> <p>Plant sources: coconut oil, hydrogenated vegetable oils, palm kernel oil</p> <p>Animal sources: butter, ghee, fats, organ meats, whole milk and its products, cheese, ice-cream, cream, red meat and other fatty meats</p> <p>Stearic acid is a saturated fatty acid found in cheese, fish, dairy, grains, and eggs that is converted to oleic acid, a beneficial omega-9 fatty acid. Stearic acid may be used as a substitute for trans-fats.</p> <p>Multiple studies have shown that it does not increase LDL-C or total cholesterol levels in isolation.</p> | <p>Liquid at room temperature and in the refrigerator</p> <p>Help the body to get rid of newly formed cholesterol.</p> <p>Fish oil, corn oil, sunflower oil, soybean oil, fish, safflower oil,</p> | <p>Liquid at room temperature but start to solidify in the refrigerator</p> <p>Decrease total cholesterol and LDL levels</p> <p>Certain nuts, avocados, canola oil, olive oil, almond oil, groundnut oil, mustard oil, cottonseed oil, sesame oil and nuts</p> | <p>Produced by a process called 'Partial Hydrogenation' whereby a vegetable oil is converted into a semi-solid</p> <p>Not only increases LDL cholesterol but they also decrease HDL cholesterol</p> <p>Snack Foods – crackers, chips, cookies, deep fried foods, biscuits</p> <p>Baked Goods – cakes, pies, pastries, and breads</p> <p>Processed Foods – margarine, salad dressings, potato products, meat products, french-fries and most shortenings</p> <p>Reusing and reheating refined oils increase trans fat (should be avoided)</p> <p>TRFA intake should be &lt;1% of the total energy intake</p> |

**Sources of  $\alpha$ - Linolenic Acid (ALNA) or  $\omega$ -3 fatty acid:** Oily and fatty fishes like salmon, mackerel, sardines, herrings, tuna, fish oils, other oils (such as linseed, rapeseed soyabean, mustard, olive, canola and flaxseed) are important sources.

**ALNA** can be obtained easily through vegetable sources like wheat, bajra, urad dal, mung dal, lobia, rajma, soyabean, green leafy vegetables, fenugreek seeds (methi), mustard seeds (rai) almonds and walnuts.

**LA (Linoleic Acid) or  $\omega$ -6 fatty Acids:** Corn oil, sunflower oil, safflower oil, soyabean oil, cottonseed oil, cereal, pulses and animal fat. It has anti-thrombotic effect which is related to n6/n3 ratio. A modest increase in ( $\omega$ -3 FA) can easily be achieved if part of total veg oil intake is from mustard oil. A judicious combination of cereals, pulses, vegetables, milk and variety of vegetable oils helps in maintaining a desirable P/S fats ratio ( $\sim$ 0.8-1.0). Fat from varied sources is better than any single type but moderate total intake.

**Table 12.3: Alpha Linolenic Acid (Omega-3) Content of Foods (g/100g)**

| <b>Foods</b>                                                  | <b>(g)ALNA</b> |
|---------------------------------------------------------------|----------------|
| <b>Cereal/Millet</b>                                          |                |
| Wheat & Pearl millet (bajra)                                  | 0.14           |
| <b>Pulses</b>                                                 |                |
| Blackgram (kalachana), kidney beans (rajmah) & cowpea (lobia) | 0.5            |
| Other pulses                                                  | 0.16           |
| <b>Vegetables</b>                                             |                |
| Green leafy                                                   | 0.16           |
| Other Vegetables                                              | 0.025          |
| Fruits                                                        | 0.025          |
| <b>Spices</b>                                                 |                |
| Fenugreek seed (methi)                                        | 2.0            |
| Mustard (sarson)                                              | 10.0           |
| <b>Unconventional</b>                                         |                |
| Flaxseed (alsi)                                               | 20.0           |
| Perilla seeds (Bhanjira)                                      | 33.0           |

Obtained from Dietary Guidelines for Indians -A Manual NIN, ICMR 2011

**Fat and fatty acid intake and CVD:** Various epidemiological, clinical and mechanistic studies have

established that risk of coronary heart disease is abridged by 2-3 % when 1% of total calorie intake from saturated fatty acid is substituted with poly unsaturated fatty acid. Therefore, it is recommended to replace the foods rich in saturated fatty acid by monounsaturated/polyunsaturated fatty acid for health benefits. The intake of SFA should not exceed 10 % of the total daily energy intake.

It has also been seen that the replacement of saturated fatty acid or carbs with unsaturated fatty acid has beneficial influence on serum HDL cholesterol level. The intake of trans fatty acid should not exceed more than 1% of the total calorie intake. It has been seen that only 2% increase in the total daily calorie intake from trans fatty acid is linked with a 23% upsurge in the frequency of coronary heart disease.

**Dietary fibers** are important dietary components having cardio protective effect. Incidence of cardiovascular diseases is lower in people consuming high dietary fiber as supported by a growing number of observational studies. Insoluble fibers have been most consistently associated in lowering the CVD incidence. Eating a balanced healthy and a diversified diet based on whole grain cereals, millets, pulses, legumes, green and dried beans, fresh and seasonal fruits and vegetables and green leafy vegetables (GLVs) will have adequate amount of insoluble and soluble fibers which helps to maintain weight and in turn helps to prevent and control various risk factors of CVD. General public must be educated and encouraged to increase the intake of whole grains, cereals and millets instead of refined grains.

**Salt and Sodium Intake:** The daily salt should not be more than 5 g of sodium chloride (or about 2 g of sodium)/day. For making a low salt diet palatable natural herbs, condiments and spices can be used as taste and flavour accompaniments. Dietary intake of sodium from sources like pickles, chutneys, namkeen, dals, papads, bakery items, potato chips, popcorn, salty biscuits, preserved meat products, other pre-prepared and preserved foods, soups, cheese, and junk / fast foods should be avoided or limited. Avoid processed foods that have high salt content. The American Heart Association endorses to restrict the sodium to no more than 1,500 mg/day. Limiting it to no more than 2,400 mg/day will improve blood pressure considerably and also decrease the risk for CVD. However various studies across different districts in India have reported that average daily salt intake ranges between 9 and 12 g which is quite high as compared to WHO recommendation of salt intake < 5 g / day.

**Read food labels:** Everyone should develop the habit of reading the food labels to check hidden sources of dietary sodium. It also helps them to choose foods that have lower amount of sodium. Foods containing more than 400 mg of sodium per serving should be avoided which is equivalent to one gram of salt. (400 mg sodium = 1g Salt)

**Consumption of sugar:** Consumption of sweetened food / beverages should be kept as minimum as possible or better to avoid. Prefer whole fruits instead of sugary and fatty desserts. It is recommended that dietary intake of sugar and simple carbs should not be more than 10 percent of daily energy intake. However, for cardio protective effects lower intakes are generally better. Simple sugars have adverse metabolic effects and also it contains empty calories.

**Fruits and vegetables:** The regular consumption of adequate quantity of seasonal vegetables and local, fresh seasonal fruits are essential for cardiovascular health. They are nutrient dense, low in glycemic index, rich in a variety of beneficial micronutrients and other bioactive compounds. They are also low in calories and fat, devoid of cholesterol, saturated and trans fat, high in fiber, vitamins, minerals which provide satiety and have anti-inflammatory properties. Diets rich in green leafy vegetables have significant benefits on CVD risk reduction. Consumption of fruits and vegetables has been inversely linked with the risk for developing hypertension, diabetes and CVD. The recommendation is to include 5 servings of fruits and vegetables per day. However per capita

consumption of fruits and vegetables in India is found to be around ~140 g/ day which is very less. The focus should be on to increase its consumption.

**Increasing consumption of other micronutrients:** Rainbow diet should be considered; the foodplate should be kept as vibrant and colourful as possible by including lots of vegetables and seasonal low calorie and low glycemic index fruits to improve the nutritional quality and adequacy of diet. Local and regional millets need to be included in the diet as these are rich in numerous micronutrients. Diversified diets with judicious food choices from a variety of food groups provide all the necessary nutrients. Choose healthy snack options (fresh fruits, vegetables and mix sprouts bhel instead of biscuits, cake, pastries, dalmaths, cookies, fried foods, junk and fast foods etc.) Inclusion of local nuts, seeds, spices and herbs may also be included to get both micronutrients and bioactive compounds and phytonutrients.

**Managing hyperlipidemia:** Limiting foods high in sugar and fat. Portion size control, moderation and variety in diet, maintain ideal body weight or reduce weight (if overweight/obese) and inclusion of regular physical activity avoiding alcohol beer, wine, or hard liquor. Avoid Sugar: candy and regular soda. Prefer complex carbohydrates in place of simple and refined carbohydrates. Replacing some carbohydrates with monounsaturated fats help to lower blood glucose levels and triglycerides

**Fruits and vegetables:** Vegetables are generally satiating, have a low glycemic index profile, and are rich in a variety of beneficial micronutrients, such as fiber, vitamins, minerals, and phytochemicals. Diets rich in leafy green vegetables have significant benefits on CVD reduction, likely due to multifactorial mechanisms.

These include vascular benefits, such as conversion of inorganic nitrates to nitric oxide, and antioxidant and anti-inflammatory benefits from lutein (carotenoid). Vegetable consumption has furthermore been inversely correlated with the risk for developing hypertension, type 2 diabetes mellitus and CVD. Whole fruits are similarly recommended across a variety of heart-healthy diets due to their antioxidant and anti-inflammatory effects, high satiety profile, and generally low glycemic index. Berries in particular are associated with flavonoids called anthocyanin, which regulate endothelial function and glycemic metabolism, they are nutrient dense with anti-inflammatory components (Low in energy and fat, high in fiber and vitamins and minerals, devoid of cholesterol saturated and trans fats). WHO recommends: 5 servings of fruits and vegetables, In India: per capita consumption of fruits & vegetables is 14g/ day (2 servings/day). Very few trials examining provision of, or advise to increase consumption of fruits and vegetables as a single intervention for the primary prevention of CVD.

**Reading food labels:** Reading food labels to determine nutrient content of the commercial foods should be encouraged so that hidden sources of sodium and carbohydrates can be identified.

**Physical Activity** Physical inactivity is considered as bad as smoking. Regular physical activity helps in maintaining ideal body weight. It also reduces the risk of CVD. WHO has recommended that adults and elderly should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent. One must start with short duration activity and gradually increase the duration or intensity. Muscle-strengthening activities on two or more days a week is also beneficial. Physical activity is associated with lower risks which causes mortality and cardiovascular events.

**Screen time;** Limit TV/Computer time to no more than 2 hours per day.

**Quit bad habits:** Quitting smoking, tobacco and alcohol consumption is helpful for CVD risk reduction.

Practicing yoga, meditation, relaxation and any other de-stressing therapies or stress buster techniques are also very important for healthy lifestyle.

Appropriate dietary amendment seems to be the cornerstone in the clinical management of CVD prevention. Emphasis should be on adopting a practice of following a diet high in seasonal locally available fruits, whole grains and local millets, legumes, and non-starchy vegetables. Avoid trans-fats, saturated fats, sodium, red meat and refined, processed and ultra-processed carbohydrates, and sugar-sweetened beverages. The Dietary Approaches to Stop Hypertension (DASH), Mediterranean, and vegetarian diets have reported to have significant impact on CVD prevention. Individualized dietary counselling and lifestyle modification is an essential feature of primary and secondary prevention of hyperlipidaemia, hypertension, type 2 diabetes mellitus, and CVD. Prompt and suitable nutritional interventions are vital for gradual and sustainable weight loss and prevention of metabolic syndrome and hence helps in the CVD prevention.

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## **12.6 ATHEROSCLEROSIS**

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Atherosclerosis is a chronic condition characterized by the buildup of plaques in arterial walls, leading to narrowing and reduced blood flow. It is caused by factors like high LDL cholesterol, hypertension, smoking, diabetes, obesity, and genetic predisposition. Symptoms depend on the affected arteries and may include chest pain, shortness of breath, stroke, leg pain, or kidney dysfunction. Diagnosis involves physical exams, blood tests, and imaging techniques like ultrasounds and angiography. Prevention focuses on a heart-healthy diet, regular exercise, smoking cessation, weight management, and controlling blood pressure and cholesterol. Treatment includes lifestyle changes, medications such as statins and antihypertensives, and surgical interventions like angioplasty or bypass surgery. Dietary management emphasizes reducing saturated fats, trans fats, and sodium while increasing fiber, unsaturated fats, and omega-3s from sources like fatty fish. Early diagnosis and a comprehensive management approach can significantly reduce complications, improving overall cardiovascular health.

### **12.6.1 ETIOLOGY OF ATHEROSCLEROSIS**

Atherosclerosis is a multifactorial disease characterized by the buildup of plaques within the arterial walls, leading to the hardening and narrowing of arteries. The primary etiological factors include elevated levels of low-density lipoprotein (LDL) cholesterol, which infiltrates the endothelium and undergoes oxidation, triggering an inflammatory response. This inflammation attracts macrophages that consume oxidized LDL, transforming into foam cells and forming fatty streaks—the earliest signs of plaque development. Other significant risk factors encompass hypertension, smoking, diabetes mellitus, obesity, and a sedentary lifestyle. Additionally, chronic inflammation, oxidative stress, and endothelial dysfunction contribute to the progression of atherosclerosis by promoting smooth muscle cell migration and proliferation, extracellular matrix deposition, and further lipid accumulation within the arterial wall.

### **12.6.2 SYMPTOMS OF ATHEROSCLEROSIS**

Atherosclerosis is often asymptomatic in its early stages, making early detection challenging. However, as plaques grow and arteries become significantly narrowed or blocked, symptoms begin to manifest depending on the affected vascular beds. In coronary arteries, atherosclerosis can lead to angina pectoris—chest pain resulting from reduced blood flow to the heart muscle—and may culminate in myocardial infarction (heart attack) if a plaque ruptures and forms a thrombus. In the cerebral arteries, it increases the risk of transient ischemic attacks (TIAs) and strokes due to impaired blood flow to the brain. Peripheral artery disease (PAD) caused by atherosclerosis in the limbs results in symptoms like intermittent claudication (pain during walking), numbness, and in severe

cases, critical limb ischemia requiring amputation. Additionally, atherosclerosis in the renal arteries can lead to hypertension and kidney dysfunction. Systemic symptoms may include fatigue and reduced exercise tolerance, reflecting the overall impact of compromised arterial circulation.

### 12.6.3 DIAGNOSIS OF ATHEROSCLEROSIS

Diagnosing atherosclerosis involves a combination of clinical evaluation, imaging studies, and laboratory tests to assess risk factors and the extent of arterial plaque buildup. Clinicians begin with a thorough medical history and physical examination, focusing on risk factors such as hyperlipidemia, hypertension, diabetes, smoking, and family history. Blood tests are essential to measure lipid profiles, including total cholesterol, LDL, high-density lipoprotein (HDL) cholesterol, and triglycerides, as well as markers of inflammation like C-reactive protein (CRP). Non-invasive imaging techniques play a crucial role in visualization and assessment which includes:

- **Ultrasound (Doppler Ultrasound):** Evaluates blood flow and detects plaque in peripheral arteries.
- **Electrocardiogram (ECG) and Stress Testing:** Identify ischemic changes in the heart.
- **Carotid Intima-Media Thickness (CIMT):** Measures the thickness of the carotid artery walls as an indicator of atherosclerosis.
- **Ankle-Brachial Index (ABI):** Assesses for PAD by comparing blood pressure in the ankles and arms.
- **Computed Tomography Angiography (CTA) and Magnetic Resonance Angiography (MRA):** Provide detailed images of arterial structures and plaque characteristics.
- **Coronary Artery Calcium Scoring:** Quantifies calcified plaque in coronary arteries using CT scans.

In certain cases, invasive procedures like coronary angiography may be necessary for definitive diagnosis and to guide therapeutic interventions.

### 12.6.4 PREVENTION OF ATHEROSCLEROSIS

Preventing atherosclerosis centers on modifying risk factors through lifestyle changes and follow pharmacological interventions. Key preventive strategies include:

- **Healthy Diet:** Emphasizing a diet rich in fruits, vegetables, whole grains, lean proteins, and healthy fats (such as those from fish, nuts, and olive oil) while reducing intake of saturated fats, trans fats, cholesterol and refined sugars.
- **Regular Physical Activity:** Engaging in at least 150 minutes of moderate-intensity aerobic exercise per week to improve cardiovascular health and maintain a healthy weight.
- **Smoking Cessation:** Eliminating tobacco use to reduce endothelial damage and inflammation.
- **Weight Management:** Maintaining a healthy body mass index (BMI) to lower the risk of hypertension, diabetes and dyslipidemia.
- **Blood Pressure Control:** Managing hypertension through lifestyle modifications and medications as prescribed.
- **Diabetes Management:** Keeping blood glucose levels within target ranges to prevent vascular complications.

- **Cholesterol Management:** Using dietary strategies and medications like statins to maintain optimal lipid levels.
- **Stress Reduction:** Incorporating stress-reducing techniques such as mindfulness, meditation, and regular physical activity.

Public health measures and education aimed to promote lifestyle changes are essential for reducing the prevalence and impact of atherosclerosis in the population.

#### 12.6.5 TREATMENT OF ATHEROSCLEROSIS

The treatment of atherosclerosis involves both lifestyle modifications and medical or surgical interventions aimed at reducing symptoms, preventing complications, and halting disease progression. Medical management includes:

- **Pharmacotherapy:**
  - **Statins:** Lower LDL cholesterol levels and stabilize plaques.
  - **Antihypertensives:** Control blood pressure to reduce arterial stress.
  - **Antidiabetic Agents:** Manage blood glucose levels in diabetic patients.
  - **Antiplatelet Agents (e.g., aspirin):** Prevent thrombus formation.
  - **Beta-Blockers and ACE Inhibitors:** Improve heart function and reduce cardiac workload.
- **Lifestyle Interventions:**
  - **Dietary Changes:** Adopt a heart-healthy diet as outlined in prevention strategies.
  - **Exercise Programs:** Implement regular physical activity tailored to the patient's condition.
  - **Smoking Cessation Programs:** Provide support and resources to quit smoking.
- **Surgical and Interventional Procedures:**
  - **Angioplasty and Stenting:** Open narrowed arteries and place stents to keep them open.
  - **Coronary Artery Bypass Grafting (CABG):** Create alternative pathways for blood flow around blocked arteries.
  - **Endarterectomy:** Surgically remove plaque from arteries, commonly performed on carotid arteries to prevent stroke.

Early and aggressive treatment is crucial to prevent adverse outcomes such as heart attacks, strokes, and peripheral artery complications.

#### 12.6.6 DIETARY MANAGEMENT OF ATHEROSCLEROSIS

Dietary management is a cornerstone in both the prevention and treatment of atherosclerosis, focusing on reducing lipid levels, controlling blood pressure, and minimizing inflammation. Key dietary strategies include:

- **Reducing Saturated and Trans Fats:** Limit intake of red meats, full-fat dairy products, and processed foods containing hydrogenated oils to decrease LDL cholesterol levels.
- **Increasing Healthy Fats:** Incorporate sources of unsaturated fats, such as olive oil, avocados,

nuts, and fatty fish rich in omega-3 fatty acids, which help lower triglycerides and reduce inflammation.

- **Enhancing Fiber Intake:** Consume ample soluble fiber from oats, beans, lentils, fruits, and vegetables to help lower cholesterol levels and improve gut health.
- **Emphasizing Plant-Based Foods:** A diet rich in fruits, vegetables, whole grains, and legumes provides essential nutrients and antioxidants that protect against arterial damage.
- **Limiting Dietary Cholesterol:** Reduce consumption of high-cholesterol foods like organ meats, shellfish, and egg yolks to manage blood lipid levels.
- **Reducing Sodium Intake:** Lower salt consumption to help control blood pressure, aiming for less than 2,300 milligrams per day, and ideally around 1,500 milligrams for those with hypertension.
- **Moderating Sugar and Refined Carbohydrates:** Decrease intake of sugary beverages, sweets, and refined grains to prevent insulin resistance and obesity.
- **Incorporating Antioxidant-Rich Foods:** Foods high in vitamins C and E, selenium, and flavonoids help combat oxidative stress and inflammation within the arteries.
- **Maintaining Adequate Protein Intake:** Choose lean protein sources such as poultry, fish, legumes, and plant-based proteins to support overall health without contributing to lipid abnormalities.
- **Alcohol Moderation:** If consumed, alcohol should be limited to moderate levels—up to one drink per day for women and two for men—to avoid adverse cardiovascular effects.

Adhering to these dietary principles not only aids in managing atherosclerosis but also promotes overall cardiovascular health, reducing the risk of recurrent events and enhancing quality of life.

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## 12.7 HYPERTENSION

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Hypertension (HTN) is characterized by high blood pressure. Blood pressure (BP) is the force circulating blood against the inner walls of blood vessels. When blood flows through the blood vessels with a force more than that considered healthy for an individual is known as HTN. Majority of people are living a sedentary lifestyle and having a faulty eating/ dietary habit leading to increase in the incidences of HTN and is now considered to be one of the major risk factors for coronary artery disease, heart failure, kidney failure and other medical complications.

About 1/3<sup>rd</sup> world's adult population are hypertensive and is a major cause of premature mortality in spite of considerable progresses in medicinal treatments but fortunately growing evidences also support the use of various dietary and lifestyle interventions for the prevention and supportive treatment of HTN.

Blood pressure measures the force of blood against the walls of the arteries. Systolic means the pressure while the heart beats whereas diastolic pressure is measured as the heart relaxes. Hypertension is continuous elevation of blood pressure. Hypertension is defined as systolic blood pressure (SBP)  $\geq 140$  mmHg, diastolic blood pressure (DBP) of  $\geq 90$  mmHg, or person on antihypertensive medications.

### 12.7.1 PREVALENCE OF HTN

It is predictable that nearly 140 million people are hypertensive and projected number for 2030 is 214 million in India. Nearly one third of the males and females (33% males and 32% females) more than 25 years are hypertensive and several others lie in pre-hypertensive stage.

There seems to be an increase in the prevalence of hypertension with the recent modifications made in the international guidelines for diagnosis of hypertension. According to the guidelines from ACC/AHA (2017), the threshold to define hypertension has now been recognized at 130/80 mmHg, with stage 1 HTN defined as office systolic BP (SBP) of 130–139 mmHg and stage 2 HTN defined as office SBP of  $\geq 140$  mmHg. As per the guidelines by ESC/ESH (2018) a SBP of 130–139 mmHg is defined as ‘high–normal’. So going along with these recent guidelines, several individuals who were not formerly receiving medication might now be placed on treatment. This leads to an upsurge in the number of individuals treated for hypertension in the near future.

### 12.7.2 SYMPTOMS OF HTN

As per clinical manifestation, hypertension is considered as no specific complaints other than raised systolic and/or diastolic BP. Some persons may complain about symptoms like morning occipital headache, dizziness or fatigue. In severe HTN, epistaxis or blurred vision may occur. HTN is considered as silent killer and it often occurs without any obvious symptom or warning signs until more serious problem arises. In order to avoid undesirable conditions monitoring of blood pressure is crucial. It is essential to follow a healthy diet and lifestyle for the prevention and control of HTN.

### 12.7.3 CONSEQUENCES OF HTN

Adverse complications like stroke, hypertension encephalopathy, blindness, heart attack or heart failure or kidney failure may be caused by persistence of elevated blood pressure. Unfortunately, these undesirable problems may happen suddenly without any warning. So, it is recommended to keep the blood pressure under target range to avoid major health related consequences.

### 12.7.4 TREATMENT THROUGH LIFESTYLE INTERVENTIONS

The promotion of lifestyle interventions especially regular exercise, maintenance of ideal body weight or weight reduction in persons with obesity requires a healthy diet recommendation. All these aimed at optimizing the prevention and management of HTN.

The ESC/ESH guidelines put the emphasis on optimal lifestyle as the only treatment required for mild hypertension during the initial 3–6 months postdiagnosis, with the commendation that medicinal treatment may be added after this duration if HTN is not well controlled. Adopting and following important measures like DASH diet, maintaining IBW, reducing salt and dietary sources of sodium, reducing high fat diet especially trans fats, avoiding alcohol, tobacco and smoking is very important in preventing and controlling HTN.

As per endorsements by joint nutrition committee JNC, 7/8 Several interventions including the DASH diet, sodium reduction, weight reduction and limiting or avoiding alcohol intake, quitting tobacco and smoking have been shown to reduce blood pressure in patients with HTN and pre-HTN. It is recommended to eat a healthy, balanced and a diversified diet that is high in whole grains cereal and millets, pulses and legumes, fresh fruits and vegetables, and low fat dairy products and so it is lower in fat, saturated fat, trans fat and adequate in potassium, calcium and magnesium. Besides eating a healthy diet, moderate level of physical activity at least 30–45 min/day or most days of the week is helpful. Distress therapy is also vital in prevention and control of blood pressure.

**Physical Activity** is very vital for prevention and control of HTN. A minimum of 30–45 minutes of physical activity of moderate intensity (such as brisk walking 5–6 km/hour) at least 5–6 days of the week is important. One must be encouraged engaging in physical activity of longer duration or more vigorous intensity such as jogging, running, cycling and swimming if possible. One can start with short duration and gradually increase the duration or intensity.

**Stress management:** Stress and anxiety may cause a temporary rise in blood pressure so try to reduce any type of stress through yoga or meditation or any other de-stressing practices as per one's

choice.

**Screen time:** Limiting screen time is vital especially high screen use at night must be avoided. Maintaining circadian synchrony is also very crucial with regular sleep wake cyclic and regular meal timings.

Table: The expected systolic BP reduction by various lifestyle interventions

| Intervention                                                                                | Recommendation                                                                           | Expected systolic BP reduction (range) |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------|
| Weight reduction                                                                            | Maintain ideal BMI (20-25kg/m <sup>2</sup> )                                             | 5-20 mmHg /10 kg weight loss           |
| DASH eating plan                                                                            | diet rich in fruit, vegetables, low-fat dairy product low in saturated and total fat     | 8 -14 mmHg                             |
| Dietary sodium restriction                                                                  | Reduce dietary sodium intake to <100mmol/day <2.4g sodium or <6 g salt (sodium chloride) | 2 - 8mmHg                              |
| Physical activity                                                                           | Regular aerobic physical activity, e.g. brisk walking for at least 30 min most days      | 4 - 9 mmHg                             |
| Alcohol in moderation                                                                       | Men $\leq$ 21 units per week<br>Women $\leq$ 14 units per week                           | 2-4 mmHg                               |
| Dietary and exercise: reduce BP by at least 10 mmHg in about 1 out of 4 people with high BP |                                                                                          |                                        |

Adopted from JAMA. 2014 Feb 5;311(5):507-20.doi: 10.1001/jama.2013.284427

### 12.7.5 DIETARY MANAGEMENT OF HYPERTENSION

**Overweight or obesity** is one of the most important risk factors for development of ofhypertension. Maintenance of desirable or ideal body weight (IBWt) is important.

**Energy:** Adequate energy to maintain IBWt or desirable body weight or lose weight if overweight or obese.

**Protein:** Normal protein is needed (0.8-1 g/kg/IBW) in the diet. Plant based protein sources seems helpful.

**Fat:** It should contribute to not more than 20-30% of the total caloric intake. In case of very obese patients' further reductions can be done.

**Dietary fibers:**Soluble as well as insoluble fibers must be included in our daily diet. The soluble fibers includebeans, seeds, citrus fruits, apple, nuts, oats, oat bran, barley, and many vegetables.

Sources of insoluble fibers include whole wheat, legumes, fruits and vegetables, whole grain cereals, millets and their products etc. Eating a balanced healthy and a diversified by wisely selecting foods from all food groups as per recommendations will provide adequate dietary fibers in daily diet which helps to maintain weight and in turns helps to prevent and control hypertension.

**Salt and Sodium:** A reduction in sodium intake is one of the most popular recommendations for the dietary management of HTN and is considered as an effective strategy for reducing BP in hypertensive patients. Restricting dietary sodium and increase in potassium to sodium ratio in diet is very crucial. Moderate sodium restriction 2-3g / day reduces diastolic pressure 6-10 mm Hg. Sodium restriction accompanied by weight reduction effectively control mild to moderate blood pressure.

It is advisable to reduce daily salt intake to <5g or <90mmol / day (with no added salt) while maintain the palatability of diet.

**Conversion of salt into Sodium:** The American Heart association recommends consuming no more than 1,500 mg of sodium per day and cutting it back to no more than 2,400 mg/d will significantly improve blood pressure. Sodium chloride or table salt is approximately 40% sodium by weight. One teaspoon or 5g of salt will have 2000 mg of sodium or around 87 mmol of sodium as equivalent weight of sodium is 23. In that way amount of sodium in particular g of salt can be calculated.

**Practical aspects of reducing salt and sodium in daily diet:** Reducing salt in cooking and preparation of meals over a period of time so that the taste buds get adopted. Meals should be prepared using the fresh ingredients and then adding a permitted amount of salt but none subsequently cook without salt and add the prescribed amount later on. Limiting or avoiding ready to eat foods, processed or canned foods or smoked meat and fish or other such products, food items prepared and cooked using Mono Sodium Glutamate (MSG). Avoid using baking soda, baking powder and MSG in daily preparation and cooking of foods as they also contain high sodium. Spices herbs and condiments can be added to make low salt diet palatable. Develop the practice of reading food labels to check the hidden sources of dietary sodium in various foods. This will help to choose foods that have lesser amount of sodium. Avoid foods containing > 400 mg Na / serving.

**Dietary Approaches to Stop Hypertension (DASH) diet:** It exerts a protective effect against blood pressure. The DASH diet comprise of the foods sources rich in potassium, calcium and magnesium, protein and fibre but low in saturated fat, trans fat, cholesterol, sugar and refined carbs. It is usually high in fresh fruits, vegetables, whole grains, legumes, nuts and low-fat dairy and dairy products, It stresses on the intake of fish and chicken rather than red meat, processed meats and sugar-sweetened beverages. The DASH diet with 2300 mg of sodium can lower blood pressure and 1500 mg of sodium may further reduce the blood pressure. The recommendation is to augment the dietary potassium intake to 3500 mg per day. Foods rich in dietary sodium should be limited or avoided. All individuals should be encouraged to eat at least 400-500 g per day of seasonal vegetables and fruits. A word of caution is that DASH diet should not be used for CKD patients or in patients with hyperkalemia (high serum potassium level).

**Other important nutrients for prevention of HTN:** calcium, potassium and magnesium food sources have protective effects. Dietary sources of calcium include milk and milk products, pulses, vegetables and greens beans, green leafy vegetables, fish, nuts, dried fruit or foods made with fortified flour, fortified soya milk and other soya products, e.g. tofu. Dietary sources of magnesium are nuts, beans, vegetables, legumes, cereals, animal products and dietary sources of potassium consist of fruits and vegetables. Studies have shown that high potassium to sodium ratio is often associated with normal blood pressure.

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## **12.8 CONGESTIVE HEART DISEASES AND HEART FAILURE**

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It is a clinical syndrome that can result from any structural or functional cardiac disorder impairing ability of ventricle to fill with or eject blood. It occurs when the heart does not pump proficiently and does not deliver enough oxygen to the body. Heart failure remains one of the foremost reasons of frequent hospitalization. Heart failure is considered as one of the major burdens on the health care in terms of morbidity, mortality and cost.

### **12.8.1 TYPES OF HEART FAILURE**

Chronic Heart Failure (CHF) is often classified into heart failure with reduced ejection fraction (HFrEF or systolic failure; most commonly happens when the left ventricle loses its ability to contract efficiently) and heart failure with preserved ejection fraction (HFpEF or diastolic failure; mainly occurs when the left ventricle cannot relax normally), decreasing the ability of the heart to fill. Heart failure with preserved ejection fraction is more frequent in elderly adults.

### **12.8.2 CAUSES OF CHRONIC HEART FAILURE**

The most common etiology of CHF is advanced age, high blood pressure, coronary artery disease, other heart diseases, genetic or viral cardiomyopathy, kidney failure, left ventricular hypertrophy, diabetes mellitus, arrhythmias, alcohol intake, tobacco and drug abuse or excessive intake of salt and foods rich in sodium. These conditions may lead to the progressive weakness of the cardiac muscles and hence the heart may not be able to maintain normal cardiac output.

### **12.8.3 SYMPTOMS OF CHRONIC HEART FAILURE**

The type and severity of signs and symptoms may vary from patient to patient depending on the stages of HF or degree of compensation or decompensation. The most common symptoms are breathlessness because of pulmonary edema, edema of feet and legs, swelling in abdomen, palpitation, cough, fatigue, difficulty in sleeping at night resulting in shortness of breath, dizziness, weakness, anorexia, nausea, vomiting, congestion, reduced exercise capacity, orthopnea (dyspnoea) on exertion, decreased cardiac output and volume overload, sometimes worsening cough, atrial fibrillation and ventricular dysrhythmia may also be observed. The heart failure symptoms may vary from mild to severe. The symptoms may appear and subside depending on treatment and response of the patients.

### **12.8.4 NUTRITIONAL MANAGEMENT OF CHRONIC HEART FAILURE (CHF)**

A multidisciplinary approach is considered to be of paramount importance in the clinical management of heart failure as the prevalence of heart failure is increasing with time. Overweight/obesity and malnutrition and/or macro- and micronutrient deficits are predominant in heart failure and it may have impact on disease trajectory therefore the dietary management of CHF patient is complex and often involves the challenge of managing multiple conditions requiring multiple medications and life style changes. It is recommended that dietitians should be an important part of multidisciplinary team for giving individualized, realistic and patient friendly meal plan and dietary counselling for every patient with regular follow-up on-going basis with diet diaries for assessing dietary compliance.

**Dietary Goal in CHF** should be

- To reduce myocardial workload
- To maintain IBW, optimize nutritional status and prevent cardiac cachexia
- To meet macro and micronutrients

- To alleviate associated symptoms and improve quality of life
- To prevent fluid overload and electrolyte imbalance
- Imparting continuous nutrition education to patient and care givers
- Disseminating knowledge on proper understanding of food and drug interaction
- Salt restriction and fluid balance depending on the symptoms

A sensible and cautious synchronization between pharmacological therapies in conjunction with nutritional management, balancing drug-nutrient interaction may aid in improving or preventing many of the symptoms accompanying CHF. Thus, it helps in decreasing the associated incidence of morbidities and mortalities.

**Management of body weight in CHF:** Trying to maintain a healthy or ideal body weight throughout the life time considerably reduces the risk of developing heart failure among obese patients. CHF patients should be weighed regularly using the SAME approach – same scale, same time, same amount of clothing. Weight gains of over 1 kg in a 48-hour period or 2.5 kg in one week should be reported to avoid fluid overload. Conversely, if the patient loses a similar amount of weight over the same period should also be reported to avoid dehydration due to over-diuresis. In that case adjustment in diuretics, fluid and salt intake may be required.

Obesity has a prevalence of 30–40% in HF with a reduced ejection fraction (HFrEF) and 40–55% in HF with preserved ejection fraction (HFpEF), making these conditions a challenge. In the case of body weight loss, the focus should be on the quality of the weight lost, and whether it is adiposity or involves muscle mass.

According to the European Society of Cardiology (ESC), weight loss cannot be recommended in patients with moderate obesity, which is in line with the recommendation of the American Heart Association (AHA). In advanced obesity, weight loss manages symptoms and exercise capacity. To address this issue, in clinical practice, it is common to recommend a negative energy balance of 500–750 kcal/d or an absolute intake of 1200–1500 kcal/d for women and 1500–1800 kcal/d for men, aiming for a loss of at least 5–10% of the weight at baseline.

**Energy:** Calorie requirements are based on residual cardiac function and ideal body weight. It has been observed that ambulatory and normal weight patients are able to tolerate around 25 Kcal/kg IBW or UBW/day. However, in obese patient's hypocaloric diets 1000-1200 Kcals may reduce stress or myocardium load. Moreover, patients with cardiac cachexia may require 1.6-1.8 times of resting energy expenditure (REE) for repletion. In case of severely undernourished patient's calorie intake should be increased gradually as increased food intake would impose enhanced burden on the heart.

Adequate amount of dietary protein intake (0.8-1.0g/kg IBW or UBW) should be recommended by including good amount of proteins particularly of HBV to facilitate tissue synthesis and prevent malnutrition. Emphasis needs to be laid on judicious combination of plant proteins (low in Na compared to animal proteins) to improve the protein quality.

**Carbohydrates:** About 55- 60% of the energy should be from carbohydrate and quality of carbohydrate needs to be modified as per presence of the associated symptoms.

**Meals:** Small amounts of food to be given as 5-6 meals (small frequent meals) and are preferable bulky, large meals. When decomposition occurs: liquid / soft, easy to digest foods requiring little or minimum mastication may be used. The diet must be low in dietary fiber and should also provide good amount of simple carbs (semolina, refined flour, de-husked pulses, papaya, mango, brinjal, pumpkin and other gourd family vegetables).

During the severe decomposition, as in coronary occlusion, the principal consideration should be rest and all attempts to feed the patient should be avoided. Sodium is restricted to 500mg.

**Salt Sodium and fluid intake:** A high salt intake may aggravate symptoms and thereby increase disease progression. Sodium restriction with or without simultaneous fluid restriction is considered as the most extensively used dietary intervention in CHF patients. Individualized dietary counselling on low-sodium diet, restricting fluids together with appropriate drugs and medications may prolong survival, improve function of the heart, ameliorate symptoms, avoid repeated episodes of decompensation, and decrease incidences and frequency of hospitalization,

Most evidence supports a moderate level of salt restriction to 2,000-3,000 mg/day. Fluid restriction should not be routinely recommended to all heart failure patients. Temporary fluid restriction is needed in decompensated heart failure and /or in dilutional hyponatremia. The Heart Failure Society of America (HFSA) prescribed a salt restriction of less than 2,000 mg per day in moderate to severe heart failure and a muchstringent low salt intakes of 1500 mg/day in stage A and stage B HF. An abrupt increase in salt intake causes a rapid increase in extracellular volume and may precipitate left ventricular failure (LVF) even in a well-compensated heart failure. So sensible eating is crucial. A positive sodium balance serves as the primary driver of water retention and ultimately volume overload.

Restriction of fluid is not required as long as the sodium is restricted. Water is retained only when there is sufficient sodium to maintain physiologic concentrations. Fluid restrictions are generally reserved for individuals taking high doses of diuretics or patients who have recurrent CHF. Maintain restricted sodium diet even if serum sodium depleted; sodium has moved from blood to tissues. Careful evaluation of serum sodium in conjunction with volume overload is needed. If hyponatremia occurs limit total fluids to less than 2000 ml.

There is no rationale for routine fluid restriction in stabilized patients with mild to moderate heart failure. Fluid restriction of 1.5–2 L/day may be considered in patients with severe symptoms, particularly if they have concurrent hyponatremia. Limit total fluid to 1000-1500 ml in case of severe decompensation, weigh every day to monitor fluid status assessment.

Personalized approach in terms of moderation of salt, sodium and fluid restriction seems useful. Continuous nutritional education is vital to sustain fluid and salt balance in HF

**Management of Fluid balance:** Handling a fluid or volume overload is an important issue in heart failure patients whereas the management window between dehydration and over hydration is narrow. The main aim is to restore fluid balance without risking further decline in cardiac performance and stroke volume.

Dietary recommendations for heart failure have conventionally focused on sodium and fluid restrictions. Patients and care givers must be educated continuously regarding the common household measures like how much common household cup, mug, bowl and glass etc hold. Record of all the fluids consumed including water, coffee, tea, milk, curd, mattha, juices, soups, vegetable gravies, rasam, coconut water, thin gravies, thin daals, porridge, desserts and any other liquids consumed must be documented. During episodes of fluid retention, patients should be encouraged to reduce fluid intake. Fluid restriction varies noticeably and each patient must be managed individually.

**Potassium Intake:** Potassium wasting diuretics (hydrochlorothiazide, furosemide) increase potassium excretion. A good source of dietary potassium is important if the patient is on diuretics (non-potassium sparing). Potassium intake is recommended unless using K sparing diuretics (Aldactone). Salt substitutes are contraindicated in renal failure and with certain other medications. It is Important to monitor a patient's potassium level as excesses of the potassium may be just as harmful as deficiencies.

**Appropriate lifestyle modification:** It is critical to maintain a healthy diet and lifestyle. Patients must be encouraged to eat a low-sodium/low salt diet. Desirable weight has to be maintained and weight reduction is needed in overweight or obese patients for reducing myocardial load. Eliminate alcohol and quit smoking.

### **Dietary Patterns**

ESC guidelines emphasize on fluid intake, regular weight monitoring, avoidance of extra salt and alcohol intake along with the adoption of common dietary guidelines for preventing CVD (as discussed in diet in CVD section).

**Other Nutritional issues:** Half of patients with severe heart failure have osteopenia or osteoporosis, especially cachectic patients. Calcium and vitamin D should be supplemented. Calcium supplements have to be given with caution in patients with cardiac arrhythmias. Monitor serum magnesium level, blood mg levels as diuretics may increase magnesium excretion; Thiamine status should be evaluated in patients on loop diuretics. Micronutrient deficiencies may be associated with heart failure attributed to anorexia, diuretic use, renal dysfunction, comorbidities induced dietary restrictions and medications altering gut health. Atrial Fibrillation (AF) is common in heart failure patients where dietary vitamin K is restricted if patient is on acitrom or on warf. All the nutritional deficiencies have to be identified and rectified.

Endorsements for dietary management of heart failure have traditionally been focused on the restriction of salt, sodium and fluid. However, emerging data supports the role of moderate sodium and fluid restriction, using a personalized approach. The use of individualized nutritional support, compared with standard recommendations, has shown effectiveness, especially in high-risk patients. Heart failure patients may do well by following low sodium, restricting fluids and nutritionally balanced diet along with prescribed medications. Individualization of fluid intake is crucial to maintain euvolemic state. Personalized, supervised tailored nutritional intervention, nutrition education and appropriate weight management is important to improve nutritional status, clinical outcomes and quality of life in heart failure.

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## **12.9 LET US SUM UP**

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Cardiovascular diseases (CVDs) encompass a range of conditions affecting the heart and blood vessels, including hypertension, congestive heart disease, and heart failure. The heart's structure, with its chambers, valves, and blood vessels, functions to pump oxygen-rich blood throughout the body, maintaining vital organ health. CVDs arise from risk factors such as hypertension, high cholesterol, diabetes, smoking, obesity, sedentary lifestyles and genetic predisposition. Symptoms vary from chest pain, breathlessness, and fatigue to swelling in extremities or irregular heartbeats. Diagnosis involves physical examinations, blood tests, ECG, echocardiography, and imaging techniques like angiography. Prevention emphasizes healthy lifestyle choices—balanced diets, regular exercise, weight control, smoking cessation, and stress management. Treatment includes medications like antihypertensives, statins, and anticoagulants, along with surgical interventions like stenting or bypass surgery when necessary. Dietary management is key, focusing on reducing sodium, saturated fats, and trans fats while increasing intake of whole grains, fruits, vegetables, lean proteins, and heart-healthy fats like omega-3s. Holistic care, combining prevention, treatment, and dietary strategies, helps mitigate risks, manage symptoms, and improve quality of life in CVD patients.

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## **12.10 CHECK YOUR PROGRESS**

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### **Short Questions**

1. What is the primary function of the heart?
2. Define atherosclerosis in one sentence?
3. Name two common symptoms of hypertension?
4. What is congestive heart failure?
5. List one dietary recommendation for managing heart diseases?

### **Long Questions**

1. Explain the structure and functions of the heart and how they are impacted by cardiovascular diseases?
2. Discuss the etiology, symptoms, and dietary management of atherosclerosis?
3. Describe the causes, prevention, and treatment strategies for hypertension?
4. Analyze the dietary considerations for managing congestive heart disease and heart failure?
5. Elaborate on the role of nutrition in preventing and managing cardiovascular diseases.

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## UNIT-13 : NUTRITION IN HORMONAL DISTURBANCES

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### Structur :

- 13.1 Introduction
- 13.2 Diabetes Mellitus
- 13.3 Symptoms Diabetes Mellitus
- 13.4 Types & etiology of Diabetes Mellitus
- 13.5 Metabolic Changes & Complications in Diabetes Mellitus
- 13.6 Diagnosis
- 13.7 Treatment
  - 13.7.1 Exercise
  - 13.7.2 Hypoglycaemic Drugs-- Insulin
  - 13.7.3 Dietary Management
- 13.8 Let Us Sum Up
- 13.9 Check Your Progress

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### 13.1 INTRODUCTION

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Consumption of highly processed foods, starchy carbohydrates, sugar, fast food, low protein diet, lack of exercise can lead to hormonal imbalance characterized by weight gain, fatigue, sleeplessness increased risk for diseases. These faulty dietary habits result in insulin resistance and metabolic syndrome. In addition, protein intake influences hormone controlling appetite and food intake. The onset and progression of diabetes mellitus is also the result of aberrant dietary patterns and once diagnosed, its management requires daily decision about food intake, blood glucose monitoring, medication and exercise.

#### Objectives

After studying this unit, you will be able to:

Describe the pathophysiology of diabetes mellitus.

Outline the epidemiology and risk factor

Differentiate between type 1 and type 2 diabetes

Understand the role of exercise, insulin therapy, hypoglycemic agents and fiber in management of diabetes mellitus.

Identify the importance of medical nutrition therapy in diabetes mellitus

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### 13.2 DIABETES MELLITUS

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Diabetes, also known as diabetes mellitus, is a group of common endocrine diseases characterized by sustained high blood sugar levels. (WHO, 2023) Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced.

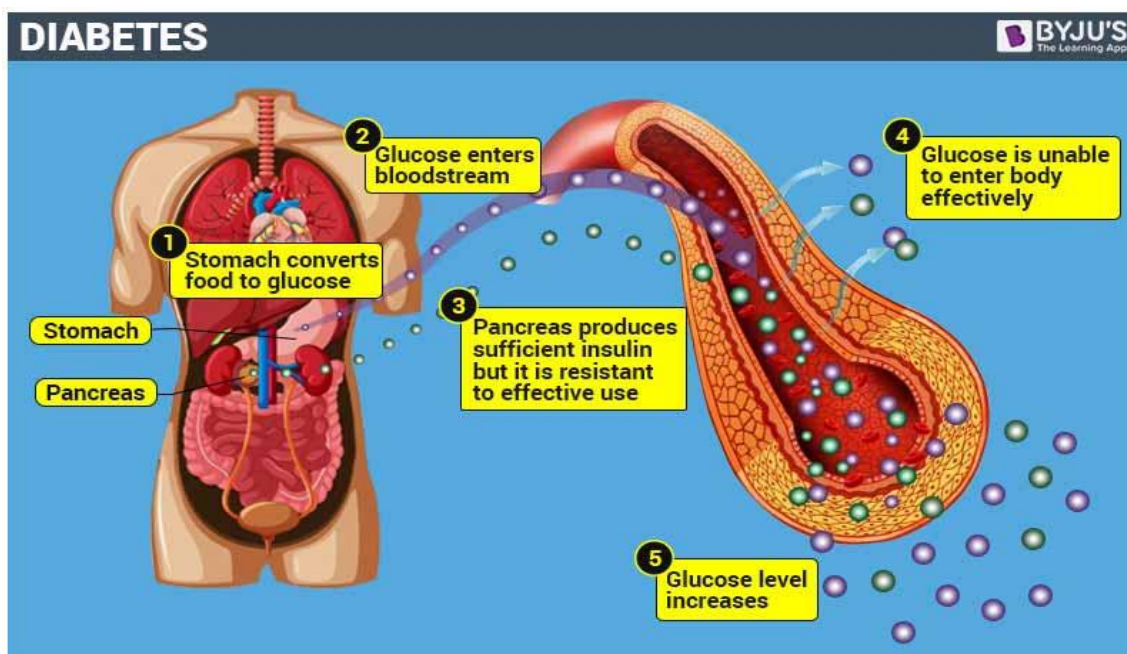
Diabetes is a chronic, metabolic disease characterized by elevated levels of blood glucose (or blood sugar), with time it leads to serious damage to the heart, blood vessels, eyes, kidneys and nerves. The

most common is type 2 diabetes, usually seen in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin. In the past three decades the prevalence of type 2 diabetes has raised dramatically in countries of all income levels. Type 1 diabetes, once known as juvenile diabetes or insulin-dependent diabetes, is a chronic condition in which the pancreas produces little or no insulin by itself. For people living with diabetes, access to affordable treatment, including insulin, is critical to their survival. There is a globally agreed target to halt the rise in diabetes and obesity by 2025 (WHO). Since 1980, the number of people with diabetes has increased. Prevalence is increasing worldwide, particularly in low- and middle-income countries. The causes are complex, but the rise is due to increase in the number of people who are overweight, including an increase in obesity due to lack of physical activity. In 2012 diabetes was the direct cause of 1.5 million deaths globally. A large proportion of diabetes and its complications can be prevented by a healthy diet, regular physical activity, maintaining a normal body weight and avoiding tobacco use.

In April 2016, WHO published the Global report on diabetes, which calls for action to reduce exposure to the known risk factors for type 2 diabetes and to improve access to and quality of care for people with all forms of diabetes (WHO, 2021).

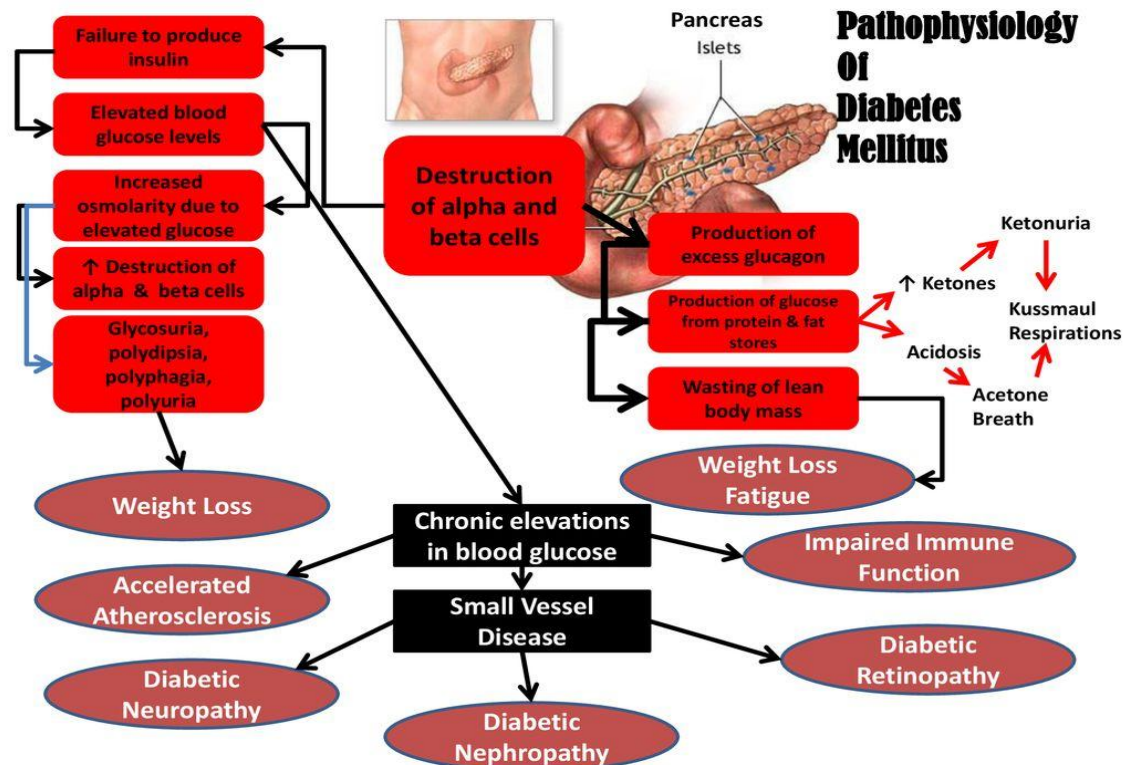
Diabetes mellitus is a Greek word meaning siphon—to pass through and in the Latin word mellitus means sweet. Historical review shows that the term "diabetes" was first used by Apollonius of Memphis around 250 to 300 BC. As discovered by Ancient Greek, Indian, and Egyptian civilizations the sweet nature of urine in this condition, and hence the propagation of the word Diabetes Mellitus came into being. The role of the pancreas in the pathogenesis of diabetes was discovered by Mering and Minkowski, in 1889. The hormone insulin from the pancreas of cows at the University of Toronto was purified in 1922 by Banting, Best, and Collip, leading to the availability of an effective treatment for diabetes in 1922. Exceptional efforts and researches, over the years have led to multiple discoveries and management strategies. Unfortunately, even today, diabetes is one of the most common chronic disease in the country and worldwide.

### Pathophysiology



**Fig 13.1: Pathophysiology of diabetes mellitus**

Source: <https://byjus.com/biology/diabetes-mellitus/>



Insulin is the principal hormone that regulates the uptake of glucose from the blood into most cells of the body, especially liver, adipose tissue and muscle. Insulin production is more or less constant within the beta cells. Its release is triggered by food, chiefly food containing absorbable glucose. Therefore, deficiency of insulin or the insensitivity of its receptors play a central role in all forms of diabetes mellitus [ADA, 2014].

The body obtains glucose from three main sources: the intestinal absorption of food; the breakdown of glycogen (glycogenolysis), the storage form of glucose found in the liver; and gluconeogenesis, the generation of glucose from non-carbohydrate substrates in the body. Insulin plays a critical role in regulating glucose levels in the body. It can inhibit the breakdown of glycogen or the process of gluconeogenesis, by stimulating the transport of glucose into fat and muscle cells, and can stimulate the storage of glucose in the form of glycogen [Shoback & Gardner, 2011].

If the amount of insulin available is insufficient, or if cells respond poorly to the effects of insulin (insulin resistance), or if the insulin itself is defective, then glucose is not absorbed properly by the body cells that require it, and is not stored appropriately in the liver and muscles. The net effect is persistently high levels of blood glucose, poor protein synthesis, and other metabolic derangements, such as metabolic acidosis in cases of complete insulin deficiency [Shoback & Gardner, 2011].

### 13.3 SYMPTOMS OF DIABETES MELLITUS

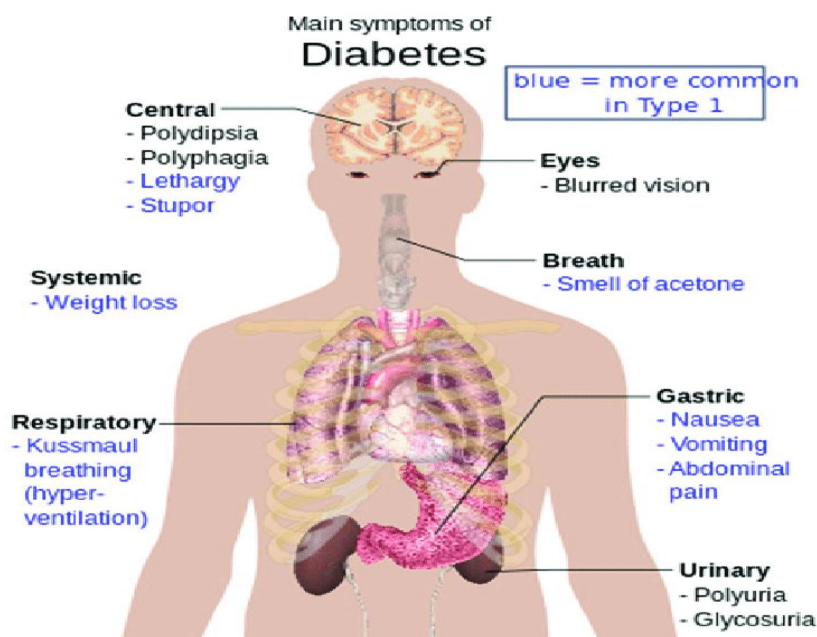
Diabetes mellitus presents with a range of symptoms, including frequent urination (polyuria) and excessive thirst (polydipsia), caused by high blood sugar levels leading to fluid imbalance. Extreme hunger (polyphagia) and unexplained weight loss occur as the body struggles to utilize glucose effectively, breaking down fat and muscle for energy. Fatigue is a common symptom due to inadequate energy supply to cells. Blurred vision may develop from changes in the eye's lens caused by elevated glucose. Slow-healing wounds and frequent infections are attributed to impaired immune

function and reduced blood flow. Tingling or numbness, especially in the extremities, results from nerve damage (diabetic neuropathy). Early detection and management of these symptoms are vital to prevent long-term complications. Some symptoms are as follows:

- Hyperglycemia
- Glycosuria
- Polyuria
- Polydipsia
- Polyphagia
- Prolonged wound healing

When glucose concentration in the blood remains high over time, the kidneys reach a threshold of reabsorption, and the body excretes glucose in the urine (glycosuria). (Murray RK, et al., 2012) This increases the osmotic pressure of the urine and inhibits reabsorption of water by the kidney, resulting in increased urine production (polyuria) and increased fluid loss. Lost blood volume is replaced osmotically from water in body cells and other body compartments, causing dehydration and increased thirst (polydipsia). (ADA, 2014) In addition, intracellular glucose deficiency stimulates appetite leading to excessive food intake (polyphagia).

Wounds can take longer to heal. These wounds often appear on the feet and legs. The risk of developing infections and other complications increase due to slow healing. White blood cells (WBCs) play a pivotal role in providing immunity but, the functioning of white blood cells is (WBC) impaired when blood glucose level remains permanently high. The uncontrolled diabetes also affects circulation, resulting in slow movement of blood and delayed delivery of nutrients to wounds. As a result, wound healing takes prolonged time in diabetics.



**Fig 13.2: Symptoms of diabetes mellitus**

Source: [https://www.researchgate.net/figure/Showing-signs-and-Symptoms-of-type-II-Diabetes-World-health-organization-WHO-has\\_fig2\\_326388084](https://www.researchgate.net/figure/Showing-signs-and-Symptoms-of-type-II-Diabetes-World-health-organization-WHO-has_fig2_326388084)

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## 13.4 TYPES & ETIOLOGY OF DIABETES MELLITUS

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Diabetes is classified as follows by American Diabetes Association (ADA, 2017)

- I. Type 1 diabetes (T1DM)
- II. Type 2 diabetes (T2DM)
- III. Gestational diabetes mellitus (GDM)
- IV. Specific type of diabetes due to other causes

### **I. Type 1 Diabetes Mellitus (T<sub>1</sub>DM)**

- i. Endogenous insulin is absent.
- ii. Type I diabetes is an autoimmune disorder, in which the body develops antibodies against insulin and/or pancreatic B-cells that produce insulin. This eventually results in not enough insulin for a person to survive.
- iii. Rapid onset, manifestations are acute: 3 P's
  - a. Polydipsia (excessive thirst)
  - b. Polyuria (frequent urination)
  - c. Polyphagia (excessive hunger)
- iv. Will require exogenous insulin for the rest of their life.
- v. No cure.

Risk factors for type 1 diabetes

- Certain genetic haplotypes
- Unknown environmental factors

### **II. Type 2 Diabetes Mellitus (T<sub>2</sub>DM)**

- i. The most prevalent type of diabetes, accounting for approximately 90% to 95% in patients with diabetes. Type 2 diabetes is characterized by a combination of inadequate insulin secretion and insulin resistance. Pancreas usually produces some endogenous insulin however the body either does not produce enough insulin or does not use it effectively, or both.
- ii. Usually controlled with diet and exercise, although may need insulin at times.

**Risk factors for type 2 diabetes:**

- Overweight/obesity
- Physical inactivity
- Age
- Diabetes in first degree relatives
- History of gestational diabetes
- Cardiovascular disease and its risk factors

- Ethnicity (South Asian, Afro-Caribbean, Hispanic)

**Table 13.1: Comparison of type 1 and 2 diabetes (Williams, 2011)**

| FEATURE            | TYPE 1 DIABETES    | TYPE 2 DIABETES                |
|--------------------|--------------------|--------------------------------|
| Onset              | Sudden             | Gradual                        |
| Age at onset       | Mostly in children | Mostly in adults               |
| Body size          | Thin or normal     | Often obese                    |
| Ketoacidosis       | Common             | Rare                           |
| Endogenous insulin | Low or absent      | Normal, decreased or increased |
| Heritability       | 0.69 to 0.88       | 0.47 to 0.77                   |

### III. Gestational Diabetes Mellitus (GDM)

Gestational diabetes mellitus (GDM) was previously defined as any degree of glucose intolerance with onset or first recognition during pregnancy. This definition included a population of women with pre-existing type 2 diabetes, so the definition has been modified to indicate that the diagnosis is after the first trimester of pregnancy. It is usually recognized at 24 to 28 weeks of gestation on the basis of abnormal glucose tolerance testing. (<https://bestpractice.bmj.com/topics/en-us/665>)

#### V. Specific type of diabetes

Specific types of diabetes due to other causes include monogenic diabetes syndromes, such as neonatal diabetes or maturity-onset diabetes of the young (MODY); diseases of the exocrine pancreas, such as severe pancreatitis; cystic fibrosis; endocrinopathies; drug- or chemical-induced diabetes, such as in the treatment of HIV/AIDS or after organ transplantation; infections; rare forms of immune-mediated diabetes; and other genetic syndromes that are associated with diabetes.

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## 13.5 METABOLIC CHANGES & COMPLICATIONS IN DIABETES MELLITUS

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Diabetes mellitus causes significant metabolic changes, including impaired glucose metabolism due to insulin deficiency or resistance, leading to hyperglycemia. The body shifts to utilizing fats and proteins for energy, resulting in ketone production and possible diabetic ketoacidosis. Chronic hyperglycemia triggers complications such as microvascular damage, causing retinopathy, nephropathy, and neuropathy, as well as macrovascular issues like cardiovascular diseases and stroke. Persistent metabolic imbalances also lead to oxidative stress and inflammation, further exacerbating tissue damage. Early intervention and effective management are crucial to minimize these complications and maintain metabolic stability.

**Table 13.2: Complications in Diabetes mellitus**

| <b>Acute complications</b>       | <b>Chronic complications</b>                           |
|----------------------------------|--------------------------------------------------------|
|                                  | <b>I.      Macrovascular complications</b>             |
| Hypoglycemia (Low blood glucose) | Cardiovascular Diseases (coronary artery disease- CAD) |
| Diabetic ketoacidosis            | Peripheral Vascular Disease (PVD- Foot problems)       |
|                                  | <b>II.     Microvascular complications</b>             |
|                                  | Retinopathy (affecting retina of the eye)              |
|                                  | Nephropathy (affecting kidneys)                        |
|                                  | Neuropathy (affecting nerves)                          |

### **Acute Complications**

Our body begins to burn fat for energy, when the cells do not get the glucose required for the energy. Ketones are the chemicals produced as a result of fat breakdown. When there is excessive accumulation of ketones in the body, it becomes toxic, leading to diabetic ketoacidosis DKA. It is a serious condition that can result in diabetic coma or even death.

Hypoglycemia or low blood glucose, occurs when there is too much insulin in proportion to available glucose in the blood. Hypoglycemia is often related to a mismatch in the timing of food intake and the peak action of insulin or oral hypoglycemic agents that increase endogenous insulin secretion.

### **Chronic complications**

Chronic complications primarily include end-organ disease due to damaged blood vessels to chronic hyperglycemia. These are divided into two categories: macrovascular complications and microvascular complications.

Macrovascular complications are diseases of the large and medium-sized blood vessels (heart, peripheral vascular system, and brain) that occur with greater frequency and with an earlier onset in people with diabetes.

Microvascular complications affect the tiny vessels of the eyes, kidneys, and nerves. They result from several pathways, all, in response to chronic hyperglycemia.

Diabetic retinopathy refers to the process of microvascular damage in the retina because of chronic hyperglycemia.

Diabetic nephropathy is a microvascular complication associated with damage to the small blood vessels that supply the glomeruli of the kidneys. High level of blood glucose puts extra load on kidneys. After many years filtration capacity of kidney is disturbed and useful protein is lost in the urine. Presence of small amounts of protein in the urine is called microalbuminuria. Having larger

amounts of protein in the urine is called macroalbuminuria. When kidney disease occurs later during macroalbuminuria, end-stage renal disease (ESRD) usually follows.

Diabetic neuropathy is nerve damage that occurs because of the metabolic derangements associated with diabetes mellitus. 60-70% of patients with diabetes have some form of neuropathy. The two major categories of diabetic neuropathy are sensory neuropathy, which affects the peripheral nervous system, and autonomic neuropathy. The most common form of sensory neuropathy is distal symmetric neuropathy, which affects the hands and/or feet bilaterally. Autonomic neuropathy can affect nearly all body systems and lead to hypoglycemic unawareness, delayed gastric emptying (gastroparesis), constipation, diarrhea, urinary retention, and sexual dysfunction.

**Complications of the Feet and Lower Extremities:** Foot complications are one of the most common causes of hospitalization in the person with diabetes. Sensory neuropathy is a major risk factor for lower extremity amputation. Proper care of foot ulcers is critical to prevent infections. Because of the loss of protective sensations, proper care of the feet in patients with diabetes is critical.

**Integumentary Complications:** Up to two thirds of patients with type 1 and type 2 diabetes develop diabetes-related skin problems. Common skin complications include acanthosis nigricans, and dermatopathy. Because skin is prone to injury, special care must be taken to protect it from injury and ulceration.

**Infection-**A patient with diabetes is more susceptible to infections due to a defect in the mobilization of inflammatory cells and impaired phagocytosis by neutrophils and monocytes. Antibiotic therapy for infections, which must be prompt and vigorous, has prevented infection from being a major cause of death in patients with diabetes.

**Psychosocial Considerations:** Patients with diabetes have increased rates of mental health disorders, particularly depression. Individuals with type 1 diabetes, particularly young women, have an increased risk of developing an eating disorder in comparison to people without diabetes.

Chronic hyperglycemia also causes nonenzymatic glycation of proteins and lipids. The extent of this is measurable via the glycation hemoglobin (HbA1c) test. Glycation leads to damage in small blood vessels in the retina, kidney, and peripheral nerves. Higher glucose levels hasten the process. This damage leads to the classic diabetic complications of diabetic retinopathy, nephropathy, and neuropathy and the preventable outcomes of blindness, dialysis, and amputation, respectively (Unger RH & Orci L, 2010).

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## 13.6 DIAGNOSIS

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Four diagnostic tests for diabetes are currently recommended,

1. Measurement of fasting plasma glucose;
2. 2-hour (2-h) post-load plasma glucose after a 75 g oral glucose tolerance test (OGTT);
3. HbA1c
4. Random blood glucose in the presence of signs and symptoms of diabetes.

People with fasting plasma glucose values of  $\geq 7.0$  mmol/L (126 mg/dl), 2-h post-load plasma glucose  $\geq 11.1$  mmol/L (200 mg/dl), HbA1c  $\geq 6.5\%$  (48 mmol/mol); or a random blood glucose  $\geq 11.1$  mmol/L (200 mg/dl) in the presence of signs and symptoms are considered to have diabetes. If elevated values are detected in asymptomatic people, repeat testing, preferably with the same test, is recommended as soon as practicable on a subsequent day to confirm the diagnosis (WHO 2019).

**Table 13.3: Criteria for T1DM, T2DM and GDM**

| Type 2 Diabetes                                | HbA1c%   | FPG mg/dl               | PPG mg/dl                                                    |
|------------------------------------------------|----------|-------------------------|--------------------------------------------------------------|
| Normal                                         | <5.7%    | <100mg/dl               | <140mg/dl                                                    |
| <i>Diagnostic criteria for T2DM (ADA,2018)</i> |          |                         |                                                              |
| Pre diabetes                                   | 5.7-6.4% | 100-126 mg/dl           | >140-200 mg/dl                                               |
| Diabetes                                       | >6.5 %   | >126 mg/dl              | >200 mg/dl                                                   |
| Target if known case of T2DM                   | <7%      | 70-130 mg/dl            | <180 mg/dl                                                   |
| Target- T1DM (ISPAD, 2018)                     | <7.5%    | 90-130 mg/dl (Pre-meal) | 90-150mg/dl (bedtime or overnight)                           |
| Target- GDM (ADA, 2018)                        | HbA1c<6% | FBS <95mg/dl            | 1 Hour post meal BG<140mg/dl<br>2 Hour post meal BG<120mg/dl |

FPG- Fasting Plasma Glucose; PPG- Post Prandial Glucose

Source: ADA, 2018; ISPAD, 2018

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## 13.7 TREATMENT

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The treatment of diabetes focuses on managing blood glucose levels, preventing complications, and improving overall quality of life. Key components include a balanced diet tailored to individual needs, regular physical activity and weight management. Pharmacological interventions involve insulin therapy for type 1 diabetes and oral antidiabetic drugs, such as metformin, sulfonylureas, or SGLT2 inhibitors, for type 2 diabetes. Monitoring blood glucose levels is essential for adjusting treatment plans. Patient education, lifestyle modifications, and regular medical follow-ups play a vital role in achieving optimal glycemic control and preventing long-term complications.

### 13.7.1 EXERCISE

The adoption and maintenance of physical activity are critical foci for blood glucose management and overall health in individuals with diabetes and prediabetes. Recommendations and precautions vary depending on individual characteristics and health status (Colberg et. al, 2016).

Physical activity includes all movement that increases energy use, whereas exercise is planned, structured physical activity.

Exercise, together with medical nutrition therapy, forms the cornerstone of diabetes therapy. In their 2022 Standards of Medical Care in Diabetes, The American Diabetes Association (ADA) recommends that adults with diabetes participate in both aerobic activity and resistance training. They specify that this should entail at least 150 minutes of moderate-to-vigorous aerobic activity per week, spread over at least three days per week to minimize consecutive days without activity, and

two to three sessions of resistance exercise per week on nonconsecutive days.

Regular exercise is associated with prevention and minimization of weight gain, reduction in blood pressure, improvement in insulin sensitivity and glucose control, and optimization of lipoprotein profile, all of which are independent risk factors for the development of T2DM.

Exercise can enhance glucose disposal and improve insulin action, and thus can be a tool to aid in glucose regulation. Muscle contraction and contraction-mediated skeletal muscle blood flow leads to glucose uptake via insulin-dependent and independent mechanisms. Exercise-mediated glucose disposal can decrease circulating blood glucose but may be affected by other determinants of systemic glucose metabolism.

Exercise induces low amounts of reactive oxygen species (ROS) acutely, which positively stimulates oxidative damage-repairing enzyme activity and results in improved biological fitness.

Aerobic training increases mitochondrial density, insulin sensitivity, oxidative enzymes, compliance and reactivity of blood vessels, lung function, immune function, and cardiac output.

Diabetes is an independent risk factor for low muscular strength and accelerated decline in muscle strength and functional status. The health benefits of resistance training for all adults include improvements in muscle mass, body composition, strength, physical function, mental health, bone mineral density, insulin sensitivity, blood pressure, lipid profiles, and cardiovascular health.

Stretching increases range of motion around joints and flexibility but does not affect glycemic control. Balance training can reduce falls risk by improving balance and gait, even when peripheral neuropathy is present (JungHoon Lee, *et.al* 2017).

### 13.7.2 HYPOGLYCEMIC DRUGS—INSULIN

The most effective management of diabetes mellitus demands an interprofessional approach involving both lifestyle modifications with diet, exercise and pharmacologic therapies as needed to meet individualized glycemic goals. Healthcare practitioners must encourage patients to combine lifestyle modifications with oral pharmacologic agents for optimal glycemic control, particularly as type 2 diabetes mellitus progresses with continued loss of pancreatic beta-cell function and insulin production.

#### Insulin: Types and Characteristics

- Fiasp is rapid acting insulin and starts working within 2 minutes of injecting and has its maximum effect between 1 and 3 hours after the injection. The effect lasts for 3 to 5 hours.
- Rapid-Acting Insulin starts to lower blood glucose within 5 to 10 minutes after injection and has its strongest effect 30 minutes to 3 hours after injection.
- Aspart insulin and lispro insulin begins to work about 15 minutes after injection, peak in about 1 hour and continue to work for 2 to 4 hours. *Types: Insulin glulisine (Apidra), insulin lispro (Humalog), and insulin aspart (Novorapid)*
- Regular or short - acting insulin usually reaches bloodstream within 30 minutes after injection, peaks anywhere from 2 to 3 hours after injection and is effective for approximately 3 to 6 hours. *Types: Huminsulin R, Actrapid*
- Intermediate-acting insulin generally reaches the bloodstream about 2 to 4 hours after injection, peaks 4 to 12 hours later and is effective for about 12 to 18 hours. *Types: NPH (Huminsulin N, Insulatard) (Clinical Dietetics Manual, 2018)*

## Oral Hypoglycemic Medications

Sulfonylureas (glipizide, glyburide, gliclazide, glimepiride), Meglitinides (repaglinide and nateglinide)

Biguanides (metformin), Thiazolidinediones (rosiglitazone, pioglitazone),  $\alpha$ -Glucosidase inhibitors (acarbose, miglitol, voglibose), DPP-4 inhibitors (sitagliptin, saxagliptin, vildagliptin, linagliptin, alogliptin), SGLT2 inhibitors (dapagliflozin and canagliflozin), Cycloset (bromocriptine)

### 13.7.3 DIETARY MANAGEMENT

#### Objectives

1. To take care of individual nutritional needs using customized approach.
2. To maintain ideal body weight.
3. To delay or prevent complications of diabetes.
4. To develop healthy eating pattern emphasizing on nutrient dense foods rather than calorie dense foods.
5. To integrate patient's insulin regimen with patient's usual lifestyle.
6. To achieve good glycemic control.

Individualized nutrition therapy, consisting of counseling, education, and ongoing monitoring, is a cornerstone of care for people with diabetes and prediabetes.

#### Type I Nutrition

1. Meal planning should be based on balancing usual food intake and preferences with insulin and exercise patterns. Insulin dosing of the patient must be coordinated with eating habits and activity pattern.

#### Type II Nutrition

1. The goal of meal planning should be to achieve normal glucose level, lipid levels and maintaining ideal body weight. Also, serving size, calorie consumption and type of fat consumption needs to be taken care of.
2. Exercise: A very important part of diabetes and pre diabetes management is regular consistent exercise. ADA recommends 150 min/wk (30 mins, 5 days/week). Any new exercise program for patients with diabetes can be started after medical clearance.

#### Role of fiber

Fiber is essential component of a healthy diet. Improvements in insulin sensitivity and the hormones that control hunger, fullness and food intake is associated with high fiber intake.

Studies have found that the gut microbiome ferments soluble fiber in the colon, producing SCFAs that stimulate the release of the fullness hormones glucagon-like peptide-1 (GLP-1) and peptide YY (PYY) (Peter Cronin et. al 2021).

#### Medical Nutrition Therapy

American Dietetic Association introduced the term “Medical Nutrition Therapy” in 1994 to better articulate the nutrition therapy process. MNT for diabetes incorporates a process that, when implemented correctly, includes: 1) an *assessment* of the patient's nutrition and diabetes self-management knowledge and skills; 2) identification and negotiation of individually designed nutrition *goals*; 3) nutrition *intervention* involving a careful match of both meal-

planning approach and educational materials to the patient's needs, with flexibility in mind to have the plan be implemented by the patient; and 4) evaluation of outcomes and ongoing monitoring. These four steps are necessary to assist patients in acquiring and maintaining the knowledge, skills, attitudes, behaviours, and commitment to successfully meet the challenges of daily diabetes self-management.

## Major Nutrients

### Carbohydrates

Low carbohydrate diets are recommended for diabetes in many literatures. However, ADA in their 2019 position now state “research indicates that low carbohydrate eating plans may result in improved glycemia and have the potential to reduce anti hyperglycemic medications for individual with type 2 diabetes.” Further low carbohydrate diets are not recommended for pregnant and lactating women, those who have or are at risk for disordered eating and those with renal disease (Fineman, R.D., et al. 2015). Different characteristics of carbohydrates, in addition to quality and quantity needs to be emphasized. Refined foods have less fiber as compared to whole grains. Foods with higher amylose content are recommended than amylopectin. Raw and large particles are better than cooked and homogenized particles. Large size of starch is preferred over smaller particles. (Joshi, Y. K. 2008). Since, there are considerable differences in the physiological responses to different forms of carbohydrate. Glycemic Index (GI) was coined in 1981. It is defined as the glycemic response elicited by a 50 g carbohydrate portion of a food expressed as a percentage of that elicited by a 50 g portion of a reference food (glucose or white bread). GI is a measure of the post-prandial glucose response after carbohydrate consumption (NP Steyn et al, 2004). Glycemic index does not take into account the effect of a typical amount of carbohydrate in a food portion on glycemia.

Suggested cut points for classification of GI by the International Standards Organization (ISO), 2010

- High ( $GI \geq 70$ )
- Medium ( $GI$  56–69)
- Low ( $GI \leq 55$ ) GI values.

Source: (Fiona S Atkinson et al 2021)

### Table 13.4: Glycemic Index of Common Foods (2018)

Adapted from NTUITIVE 2018, National Institute of Nutrition, 2018

| Food Ingredient        | Glycemic Index |
|------------------------|----------------|
| <b>CEREALS</b>         |                |
| Barley                 | 28             |
| Maize, Tender Sweet    | 52             |
| Rice Parboiled, milled | 73             |
| Rice Raw Brown         | 72             |
| Sago                   | 70             |
| Wheat Bread (brown)    | 74             |

|                     |    |
|---------------------|----|
| Wheat bread (white) | 75 |
|---------------------|----|

**LEGUMES**

|            |    |
|------------|----|
| Lentil Dal | 32 |
|------------|----|

|             |    |
|-------------|----|
| Peas, Fresh | 39 |
|-------------|----|

|                  |    |
|------------------|----|
| Soya Bean, Brown | 16 |
|------------------|----|

**FRUIT**

|            |    |
|------------|----|
| Apple, big | 36 |
|------------|----|

|                  |     |
|------------------|-----|
| Dates, processed | 103 |
|------------------|-----|

|                              |    |
|------------------------------|----|
| Grapes, seeded, round, green | 43 |
|------------------------------|----|

|                              |    |
|------------------------------|----|
| Grapes, seeded, round, black | 59 |
|------------------------------|----|

|      |    |
|------|----|
| Kiwi | 52 |
|------|----|

|                   |    |
|-------------------|----|
| Mango, green, raw | 51 |
|-------------------|----|

|              |    |
|--------------|----|
| Orange, pulp | 43 |
|--------------|----|

|              |    |
|--------------|----|
| Papaya, ripe | 60 |
|--------------|----|

|       |    |
|-------|----|
| Peach | 28 |
|-------|----|

|           |    |
|-----------|----|
| Pineapple | 59 |
|-----------|----|

|      |    |
|------|----|
| Plum | 69 |
|------|----|

|            |    |
|------------|----|
| Strawberry | 40 |
|------------|----|

|                        |    |
|------------------------|----|
| Watermelon, pale green | 76 |
|------------------------|----|

**VEGETABLES**

|              |    |
|--------------|----|
| Tomato, ripe | 15 |
|--------------|----|

|                       |    |
|-----------------------|----|
| Pumpkin, orange round | 75 |
|-----------------------|----|

|               |    |
|---------------|----|
| Broccoli, raw | 10 |
|---------------|----|

|                |    |
|----------------|----|
| Cabbage, green | 10 |
|----------------|----|

|             |   |
|-------------|---|
| Cauliflower | 6 |
|-------------|---|

|                 |    |
|-----------------|----|
| Capsicum, green | 10 |
|-----------------|----|

|                         |    |
|-------------------------|----|
| Mushrooms               | 10 |
| Peas, fresh             | 39 |
| Onion, small            | 10 |
| Carrot, Orange          | 16 |
| Beetroot                | 64 |
| Sweet potato, pink skin | 48 |

#### **MILK**

|                      |    |
|----------------------|----|
| Milk Buffalo's       | 39 |
| Skimmed Milk, Liquid | 37 |

#### **NUTS & OILSEEDS**

|                       |    |
|-----------------------|----|
| Cashewnut             | 25 |
| Coconut, Kernel Fresh | 45 |
| Flaxseed              | 36 |
| Groundnut, roasted    | 14 |
| Walnut                | 15 |

#### **SUGARS**

|               |     |
|---------------|-----|
| Glucose syrup | 103 |
| Honey         | 61  |

In order to improve the reliability of predicting the glycemic response of a given diet, Salmeron et al have suggested the use of glycemic load. The glycemic load of a particular food is the product of the glycemic index of the food and the amount of carbohydrate in a serving.

The GL is a relatively new way to assess the impact of carbohydrate consumption that takes the GI into account but gives a fuller picture than does GI alone. A GI value indicates only how rapidly a particular carbohydrate turns into sugar. It does not indicate how much of that carbohydrate is in a serving of a particular food. Dietary GL is calculated as the sum of the product of the GI for each foodstuff and its available carbohydrate content divided by 100; thus, it represents the quantity and quality of carbohydrates in the overall diet and their interaction (Zhi-Quan Lu, Jia Yan, 2014).

Strong evidence exists that consuming high levels of fructose-containing beverages may have particular adverse effects on selective deposition of ectopic and visceral fat, lipid metabolism, blood pressure, and insulin sensitivity compared with glucose-sweetened beverages (Garber, A. J., *et.al* 2018).

**Carbohydrate Counting:** is a meal planning approach used with diabetics that focuses on carbohydrate as the primary nutrient affecting postprandial glycemic response. Advanced carbohydrate counting allows adjustment of the prandial insulin dose for actual carbohydrate intake in T1DM patients on intensive insulin therapy. Carbohydrates can be counted by using food exchange lists. Carbohydrate distribution across meals also plays a significant role depending upon the type of insulin prescribed.

#### **Dose Adjustment for Normal Eating (DAFNE)**

DAFNE is a way of managing T1DM and provides people with the skills necessary to estimate the carbohydrate in each meal and to inject the right dose of insulin. Consistent carbohydrate meal plans are preferred as they facilitate matching the prandial insulin dose to the amount of carbohydrate consumed. (ADA 2017)

In persons with T1DM or T2DM who adjust their mealtime insulin dose or who are on insulin pump therapy, insulin doses should match carbohydrate intake, known as the insulin-to-carbohydrate ratio.

#### **Insulin-to-Carbohydrate Ratio (I: C factor)**

##### **Amount of carbohydrates (grams) covered by one unit of insulin**

###### **1. Rule of 450**

---- In case of using Regular Insulin

$450/\text{Total Daily Dose (TDD)} = \text{I:C Factor}$

###### **2. Rule of 500**

--- In case of using Rapid Acting Insulin

$500/\text{Total Daily Dose (TDD)} = \text{I:C Factor}$

--- 1 unit of insulin covers 10 grams of carbohydrate if on regular insulin and 11 grams of carbohydrate if on rapid acting insulin (Clinical Dietetics Manual, 2018).

#### **Protein**

The goal of protein intake should be individualized. In order to provide evidence-based information, the Diabetes Nutrition Study Group (DNSG) used a grading procedure used for quality of evidence and strength of recommendations (GRADE). A protein intake of 10% to 20% of energy intake (E%) or about 0.8 to 1.3 g/kg body weight in people below 65 years of age, and 15% to 20% of E% in people above 65 years of age appeared safe in weight-stable conditions (Andreas F H Pfeiffer Eva Pedersen et. al 2020). Proteins from vegetarian sources are preferred as they provide fiber and do not contribute cholesterol.

#### **Fat**

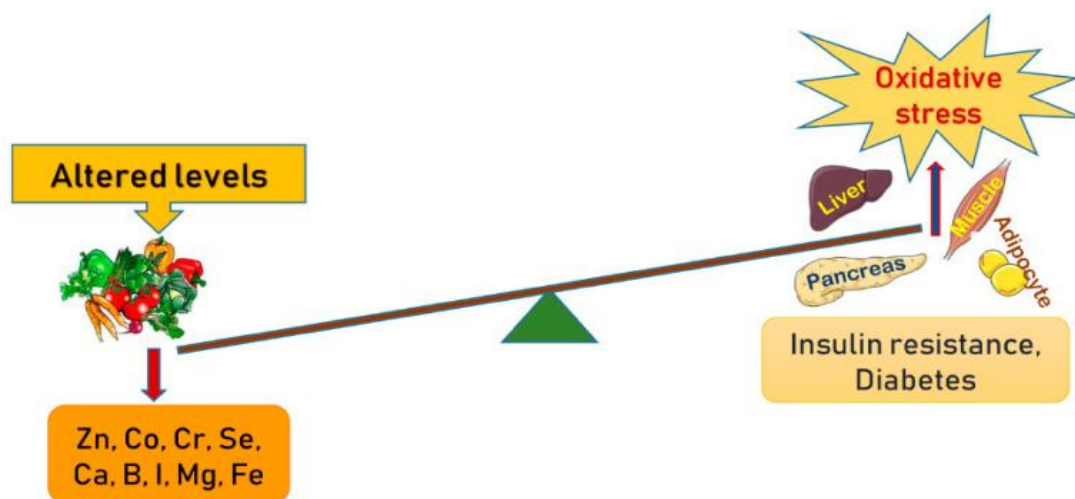
There is inconclusive evidence for an ideal amount of total fat intake for people with diabetes. The metabolic profile and the need to lose weight determine nutrition therapy recommendations. The qualities as well as quantity of fat in the diet are important. Foods containing n-3 fatty acids have cardioprotective effects. Trans fatty acids from cookies, doughnuts, breads and products fried in hydrogenated shortenings raise plasma LDL cholesterol. Therefore, intake of trans fatty acids should be limited. Plant sterol and stanol esters block the intestinal absorption of dietary and biliary cholesterol. The American Diabetes Association recommends more monounsaturated and polyunsaturated fats than saturated or trans fats in the diet.

**Table 13.5: DIETARY FATS**

| Type of Fat     | Main Source                                                                                                                                                |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Monounsaturated | Canola, peanut, and olive oils; avocados; nuts such as almonds, hazelnuts, and pecans; and seeds such as pumpkin and sesame seeds                          |
| Polyunsaturated | Sunflower, corn, soybean, and flaxseed oils, and also in foods such as walnuts, flax seeds, and fish                                                       |
| Saturated       | Whole milk, butter, cheese, and ice cream; red meat; chocolate; coconuts, coconut milk, coconut oil and palm oil                                           |
| Trans           | Some margarines; vegetable shortening; partially hydrogenated vegetable oil; deep-fried foods; many fast foods; some commercial baked goods (check labels) |

Source: <https://www.ncbi.nlm.nih.gov/books/NBK279012/>

### Micronutrients



**Fig 13.3: Role of micronutrients in diabetes mellitus**

Source: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7353202/>

## Recommendations for Medical Nutrition Therapy in the Management of Diabetes Mellitus

The Research Society for the Study of Diabetes in India (RSSDI, 2018), the American Diabetes Association (ADA, 2018), and the Indian Council of Medical Research (ICMR, 2019) provide varying guidelines for managing diabetes mellitus through medical nutrition therapy.

### Carbohydrates

It should constitute 45-65% of total daily calories (minimum 130 g/day) as per RSSDI, 55-60% per ICMR, while ADA does not specify an intake percentage. All recommend a high-fiber, low-glycemic index diet, encouraging the consumption of whole grains, legumes, fruits, and vegetables while substituting polished white rice with millets or brown rice and avoiding refined products like all-purpose flour (maida).

### Proteins

RSSDI and ICMR suggest 10-15% of total daily calories, while ADA recommends 15-20% for those without kidney disease and 0.8 g/kg body weight/day for those with renal complications. ICMR emphasizes vegetable proteins, low-fat dairy, fish, and lean meats as preferred sources.

### Fats

Intake guidelines emphasize reducing saturated fats to less than 10% of total calories (less than 7% per ICMR), minimal trans fats, and limiting dietary cholesterol to under 300 mg/day. MUFA and PUFA are preferred, with sources such as nuts, seeds, groundnut, mustard, sesame oils, and fatty fish. RSSDI and ICMR provide specific oil recommendations, avoiding sunflower oil per RSSDI.

### Sugars and Sweeteners

All recommend reducing refined sugar and high-fructose corn syrup (HFCS), with moderate use of non-nutritive sweeteners. ICMR suggests avoiding sugar, honey, jaggery, and very sweet fruits, and restricting artificial sweeteners in pregnant or lactating women.

### Micronutrients

RSSDI mentions chromium, magnesium, zinc, and alpha-lipoic acid as adjunctive care with insufficient evidence for inclusion, while ADA and ICMR do not recommend specific micronutrients. Sodium intake is limited to less than 5-6 g/day, with further restriction for hypertensive patients. Alcohol consumption should be moderate, and tobacco use is discouraged across all guidelines. These comprehensive dietary strategies aim to optimize glycemic control, prevent complications, and improve the quality of life in diabetes management.

### Non-Nutritive Sweeteners

Table 13.6: Common Artificial Sweeteners

| FDA Approved Sweeteners                           | Accepted Daily Intake (ADI)<br>(mg/kg body weight) |
|---------------------------------------------------|----------------------------------------------------|
| Sucralose                                         | 5 mg/kg body weight/day                            |
| Aspartame                                         | 50 mg/kg body weight/day                           |
| Acesulfame K<br>(Contraindicated in hyperkalemia) | 15 mg/kg body weight/day                           |

|                                                                  |                              |
|------------------------------------------------------------------|------------------------------|
| Saccharin (Contraindicated in Pregnancy)                         | 5 mg/kg body weight/day      |
| Steviol Glycosides                                               | 4 mg/kg body weight/day      |
| Siraitia grosvenorii Swingle (Luo Han Guo) fruit extracts (SGFE) | Not specified                |
| Advantame                                                        | 32.8 5 mg/kg body weight/day |
| Neotame                                                          | 0.3 mg/kg body weight/day    |

Source: Adapted from U.S Department of Health and Human Services (2015)

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## 13.8 LET US SUM UP

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Diabetes Mellitus is a metabolic disorder characterized by high blood glucose levels due to impaired insulin production or function. It presents with symptoms like excessive thirst, frequent urination, weight loss, and fatigue. The condition has two primary types: Type 1, caused by autoimmune destruction of insulin-producing cells, and Type 2, associated with insulin resistance and lifestyle factors. Uncontrolled diabetes leads to metabolic changes and complications like neuropathy, nephropathy, and cardiovascular diseases. Diagnosis involves blood tests, such as fasting blood glucose and HbA1c. Treatment includes regular exercise to improve insulin sensitivity, hypoglycemic drugs like insulin to regulate blood sugar, and dietary management. A balanced diet with a focus on low glycemic index foods, high-fiber intake, and portion control helps stabilize blood glucose levels. Managing diabetes effectively requires a comprehensive approach that integrates medical care, lifestyle changes, and nutritional strategies to prevent complications and improve overall health.

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## 13.9 CHECK YOUR PROGRESS

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### I. Fill in the blanks:

- Deficiency of insulin or the insensitivity of its receptors play a central role in all forms of -----.
- There is increased risk of diabetic ketoacidosis in -----diabetes.
- and -----improve hormonal health.
- The onset of type2 diabetes is -----.
- When glucose concentration in the blood remains high over time, the kidneys reach a threshold of reabsorption, and the body excretes glucose in the urine, termed as -----.
- ADA recommends ----- exercise as essential part of diabetes and pre-diabetes management.

### I. Suggest three recipes for diabetic patients based on locally available ingredients.

-----  
 -----

### II. Mention five important points for patient education in diabetes.

-----  
 -----

## Notes