

ANNEXURE-I

Academic Year 2026-27
Detailed Programme Structure & Syllabus
M.Sc. Botany

Year	Sem.	Course Code	Paper Title	Theory/Practical	Max. Marks.	Credits
1	I	PGBY-101(N)	Phycology	Theory	100	4
		PGBY-102(N)	Mycology and Plant Pathology	Theory	100	4
		PGBY-103(N)	Bryophytes and Pteridophytes	Theory	100	4
		PGBR-01	Basics in Research	Theory	100	4
		PGBY-105(N) (P)	Practical's based on PGBY 101N ,102N and 103 N	Practical Work	100	4
	II	PGBY-106(N)	Gymnosperms and Palaeobotany	Theory	100	4
		PGBY-107(N)	Anatomy, Reproduction and Morphogenesis	Theory	100	4
		PGBY-108(N)	Taxonomy of Angiosperm and Economic Botany	Theory	100	4
		PGED-02	Entrepreneurship Development	Theory	100	4
		PGBY -110 N (P)	Practical's based on PGBY 106 N,107 N and 108 N	Practical Work	100	4
2	III	PGBY-111(N)	Environmental Botany	Theory	100	4
		PGBY-112(N)	Plant Physiology and Biochemistry	Theory	100	4
		PGBY-113(N)	Cytogenetics and Plant Breeding	Theory	100	4
		PGRT-03	Basic Research Tool	Theory	100	4
		PGBY-115(N) (P)	Practical's based on PGBY 111 N ,112 N and 113 N	Practical Work	100	4
	IV	Compulsory Papers				
		PGBY-118(N)	Tools and Techniques	Theory	100	4
		PGBY-123(N) (D)	Dissertation based viva voce	Dissertation based viva voce	100	4
		Choose any one group (Group I OR Group II)				
		Group I				
		PGBY-116(N)	Applied Microbiology	Theory	100	4
		PGBY-117(N)/121 (N)	Bioinformatics	Theory	100	4
		PGBY-119(N) (P)	Practical's based on PGBY 116 N ,117 N and 118 N	Practical Work	100	4
		OR				
		Group II				
		PGBY-120(N)	Plant Biotechnology, Biosafety, IPR and History of Botany	Theory	100	4
		PGBY-117(N)/121 (N)	Bioinformatics	Theory	100	4
		PGBY-122(N) (P)	Practical's based on PGBY 118 N ,120 N and 121 N	Practical Work	100	4

Syllabus for M.Sc. (Botany)

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: I	Semester : I
Subject: Botany		
Course Code: PGBY-101 (N)	Course Title: Phycology	
Course Objectives: : The aim of this course is to give the students essential knowledge pertaining to the enormous diversity that Algae exhibit and equip them with the understanding of their structure and biology.		
Course Outcomes:(CO):- On successful completion of this course, the students will be able to: • Demonstrate characteristics. an understanding of various algal groups, their classification and life cycle. • Acquire knowledge about the strategies for the evolution of sex of algae and economic importance of algae.		
Credits: 04	Type of Course: Core (√) /Elective	
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Algae-I	
Unit I	Introduction • Algae Principles of important systems of classification of algae to the rank of classes Occurrence and distribution Range of the organisation Algal pigments, its significance in classification Algal reproduction and life cycles Economic and environmental aspects of algae	
Unit II	Cyanophyceae – I • Cyanophyceae (Blue-green algae): Occurrence and habitat, cellular organisation, reproduction, classification up to the rank of order, phylogeny, brief knowledge of the following genera :<i>Chroococcus</i>, <i>Gloeotrichia</i>, <i>Nostoc</i>	
Unit III	Cyanophyceae – II • Cyanophyceae (Blue-green algae): Occurrence and habitat, cellular organisation, reproduction, classification up to the rank of order, phylogeny, brief knowledge of the following genera : <i>Cylindrospermum</i>, <i>Stigonema</i>.	
Unit IV	Chlorophyceae -I • Chlorophyceae (green algae): General features, range of vegetative structure, reproduction, classification upto the order, phylogeny, brief knowledge of the following genera: <i>Chlorella</i>, <i>Hydrodictyon</i>, <i>Enteromorpha</i>, <i>Sphaeroplea</i>	
Unit V	Chlorophyceae -II • Chlorophyceae (green algae): General features, range of vegetative structure, reproduction, classification upto the order, phylogeny, brief knowledge of the following genera: <i>Cladophora</i>, <i>Draparnaldiopsis</i>, <i>Cephaleuros</i>, <i>Frittschiella</i>,	
Unit VI	Chlorophyceae -III • Chlorophyceae (green algae): General features, range of vegetative structure, reproduction, classification upto the order, phylogeny, brief	

	knowledge of the following genera: <i>Acetabularia</i> , , <i>Caulerpa</i> , <i>Closterium</i> , <i>Zygnema</i> and <i>Nitella</i> .
Block 2	Algae-II
Unit VII	Phaeophyceae – I Phaeophyceae (Brown Algae): General features, range of vegetative structure, reproduction, classification upto the order, brief knowledge of the following genera: Dictyota, Laminaria
Unit VIII	Phaeophyceae – II Phaeophyceae (Brown Algae): General features, range of vegetative structure, reproduction, classification upto the order, brief knowledge of the following genera: Fucus, Pylatella
Unit IX	Rhodophyceae-I Rhodophyceae (Red Algae): External features, life histories, classification upto the rank of orders, brief knowledge of the following genera: Porphyra, Nemalion
Unit X	Rhodophyceae-II Rhodophyceae (Red Algae): External features, life histories, classification upto the rank of orders, brief knowledge of the following genera: Gelidium Polysiphonia
Unit XI	Xanthophyceae Xanthophyceae: General features, brief knowledge of the following genera : Botrydium, Vaucheria
Unit XII	Bacillariophyceae Bacillariophyceae: General features, brief knowledge of the following genera : <i>Peridinium</i>, <i>Ceratium</i>
Suggested Text Book Readings: - Ahluwalia, A.S.,2003, Phycology: Principles, Processes and Applications, Daya Publishing House, New Delhi. - Fritsch, F.E., 1979, The Structure and Reproduction of Algae (Vol. I & II), Vikas Publishing House Pvt. Ltd., New Delhi. - Graham, L. E., Graham, J.M. and Wilcox, L.W. 2000, Algae, Prentice Hall, USA. - Kumar, H.D., 1999, Introductory Phycology, East West Press, New Delhi. - Lee, R. E., 2008, Phycology, Cambridge University Press, Cambridge, 2008.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: I	Semester: I
Subject: Botany		
Course Code: PGBY-102 (N)	Course Title: <i>Mycology and Plant Pathology</i>	
Course Objectives: The aim of this course is to give the students essential knowledge pertaining to the enormous diversity of fungi and equip them with the understanding of various aspects of plant pathology.		
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Demonstrate an understanding of various fungal groups, their classification, characteristics, reproduction and economic importance. • Understand the interaction between plant and pathogen in relation to the overall environment • Demonstrate an understanding of the principles of plant pathology and the application of these principles for the control of plant disease. • Knowledge about of various plant diseases and effect of microbial infections on plant.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Mycology	
Unit I	Introduction to Fungi • Introduction to fungi and their significance to humans, general characteristics of fungi, Fungal Cell, fungal cell walls and fungal organelles, systematics, molecular methods of fungal taxonomy, reproduction and spores in fungi, heterothallism, parasexual cycle and sex hormones in fungi.	
Unit II	Phycomycotina – I • Biology, general characteristics, importance and life cycles of Plasmodiphora, dictyosteliomycota, acrasiomycota and myzomycota.	
Unit III	Phycomycotina – II • Biology, general characteristics, classification and brief introduction of Mastigomycotina- Chytridiomyeetes, Hypochytridiomycetes and Oomycetes zygomycotina- Mucorales, Endogonales, Glomales, Entomophthorales and Zoopagales with special reference to evolutionary tendencies in thallus, asexual and sexual reproduction.	
Unit IV	Ascomycotina • Taphrinales, Schizosaccharomycetales, Saccharomycetales, Eurotiales, Hypocerales, Melanosporales, Phyllachorales, Ophiostomatales, Dioporthales, Xylariales, Sordarieales, Meliolales, Rhytismales, Helotiales, Pezizales, Dothidiales, Pleosporales and Erysiphales	
Unit V	Basidiomycotina & Decuteromycotina • Basidiomycotina- Agaricales, Lycoperdales, Sclerodermatales, Phallales,	

	Nidulariales, Aphyllophorales, Uredinales, Ustilaginales, Auriculariales and Tremellales • Deuteromycotina Hyphomycetes, Coelomyces.
Block-II	Plant Pathology
Unit VI	Concept of Plant Diseases • Historical development & present status of plant pathology, Classification of plant disease, Pathogenesis and diseases development, role of enzymes & toxins in pathogenesis- plant disease diagnosis; Koch's postulates with special reference to parasitism study of important symptoms caused by bacteria, virus & Fungi.
Unit VII	Defence Mechanism in host • Preexisting structural and chemical defence mechanism; Induced structural and biochemical defence mechanism, Hypersensitive response, Detoxins, Immunization of plants (Plantibodies), Genetically-Engineered Disease resistant plants.
Unit VIII	Dissemination of plant pathogen: • Effect of Temperature, moisture, wind, light, O₂ and CO₂ concentration, Soil PH, Host-Plant Nutrition and herbicides on diseases development. Direct and indirect dissemination of pathogen.
Unit IX	Epidemiology and Disease Forecasting • Rate and range of epidemics, elements of an epidemic, Factors affecting the epidemics. Assessment of plant disease and yield loss, Measurement of disease intensity, loss and patterns of epidemic, Forecasting of plant diseases epidemics, Disease warning and Expert systems.
Unit X	Control of plant diseases • Regulatory, Cultural, Physical, Chemical and Biological methods of Plant diseases control.
Unit XI	Plant Disease-I • Green ear disease of Bajara • Rust of Linseed • Rust of wheat • Covered Smut of barley • Loose Smut of wheat • Tikka disease of ground nut
Unit XII	Plant Disease-II • Early blight of potato • Stem gall of coriander • Downy mildew of cucurbits • Wilt of Arhar

	• Blast of rice • Late Blight of Potato
Suggested Text Book Readings: 1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology, John Wiley and Sons, New York. 2. Kirk, P.M., Canon, P.F., Minter, D.W. and Stalpers, J.A. Dictionary of the Fungi (10th Edition), CAB International, U.K, 2008. 3. Mehrotra, R.S. & Aneja, K.R., 2015. An Introduction of Mycology, New Age International Press, New Delhi. 4. Bilgrami, K.S. and Dube, H.C., (1990), A Text Book of Modern Plant Pathology, Vikas Publishing House, New Delhi. 5. Mehrotra, R.S. and Aggarwal, A., (2013), Fundamentals of Plant Pathology, Tata Mc Graw Hill Publ. Ltd., New Delhi. 6. Mehrotra, R.S. and Ashok Aggarwal (2017): Plant Pathology, Tata Mc Graw Hill Publ. Ltd., New Delhi. 7. Singh, R.S., (2018), Plant Disease, 9th Edition, Oxford, IBH Publ., New Delhi. 8. Singh, R.S., (2017), Principles of Plant Pathology, 5th Edition, Medtech.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: I	Semester: I

Subject: Botany	
Course Code: PGBY-103 (N)	Course Title: Bryophytes and Pteridophytes
Course Objectives: The aim of this course is to give knowledge of bryophytes and familiarize the students the classification of Pteridophytes, comparative study of morphological and reproductive characters of Pteridophytes.	
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Describe characteristic features of bryophytes and their classification; will be able to learn about the strategies for the evolution of land habit of bryophytes. • Gain knowledge about the invitro reproduction of bryophytes and their economic importance. • Enhance the knowledge for general introduction, origin and evolution of Pteridophytes. • Demonstrate an understanding of comparative morphology and reproduction of various Pteridophytes.	
Credits: 04	Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks:36
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)	
Block 1	Bryophytes
Unit I	Hepaticopsida • General characteristics, life cycle and classification of bryophytes, origin and evolution of gametophyte and sporophytic, moss protonema, economic importance of bryophytes.
Unit II	Study of Calobryales and Metzgeriales • Characteristic features, range of gametophytic and sporophytic organization (morphology, anatomy and their distribution in India) in various orders families of the class. Calobryales - <i>Calobryum</i> Metzgeriales - <i>Riccardia, Metzgeria</i>
Unit III	Jungermannials and Sphaerocarpales • Characteristic features, range of gametophytic and sporophytic organization (morphology, anatomy and their distribution in India) in various orders families of the class. Jungermannials - <i>Jungermannia, Porella, Radula</i> Sphaerocarpales - <i>Riella</i>
Unit IV	Monocleales and Marchantiales • Characteristic features, range of gametophytic and sporophytic organization (morphology, anatomy and their distribution in India) in various orders families of the class. Monocleales - <i>Monolea</i> Marchantiales - <i>Plagiochasma</i>
Unit V	Anthocerotopsida • Characteristic features, range of gametophytic and sporophytic organization (morphology, anatomy and their distribution in India) in various orders families of the class. Antocerotaceae - <i>Anthoceros</i> Notothyladaceae - <i>Notothylas</i> Dendrocerotaceae - <i>Dendroceros</i>
Unit VI	Bryopsida

	Characteristic features, range of gametophytic and sporophytic organization (morphology, anatomy and their distribution in India) in various orders families of the class. Sphagnales - <i>Sphagnum</i> Andreaeales - <i>Andreaea</i> Polytrichales - <i>Polytrichum</i>
Block 2	Pteridophytes
Unit VII	General Pteridophytes-I General Introduction of pteridophytes, their peculiar features and similarities and dissimilarities with bryophytes and gymnosperms, pteridophytes classification based on molecular data by smith et al 2006. World distribution of pteridophytes with special reference to India, Endangered pteridophytes their conservation.
Unit VIII	General Pteridophytes-II Origin and Evolution of pteridophytes, Gametophytes of pteridophytes, ecology of pteridophytes. Stomatal structures in pteridophytes, Spores of pteridophytes. Apospory and parthenogenesis. Sex organs and embryogeny in Pteridophytes, Economic importance of pteridophytes, Cytogenetics of pteridophytes.
Unit IX	Comparative study of Pteridophytes-I Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: Early land plant and their evolutionary significance, Psilopsida, Lycopsida, Sphenopsida, Filicopsida. Coenotoperidales
Unit X	Comparative study of Pteridophytes-II Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: Ophioglossales, Marattiales, Osmundales and Filicales; Monographic study of <i>Isoetes</i>
Unit XI	Comparative study of Pteridophytes-III Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: <i>Psilotum</i>, <i>Ophioglossum</i>,
Unit XII	Comparative study of Pteridophytes-IV Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: <i>Osmunda</i>, <i>Lygodium</i>, <i>Cyathea</i>, <i>Gleichenia</i>, <i>Adiantum</i>, <i>Pteris</i>, <i>Chistella</i> and aquatic ferns.
Suggested Text Book Readings: - Goffinet, B. and Shaw, A.J. 2008, Bryophyte Biology (2nd Edn.), Cambridge University Press, Cambridge. Page23 - Rashid, A. 1998, An Introduction to Bryophyta. Vikas Pub. House Pvt.Ltd., New Dehli. - Schofield, W.B. 1985, Introduction to Bryology, Macmillan, New York. - Vasishta, B. R. 1996, Bryophyta, S.Chand& Co. Ltd., New Delhi - Parihar, N.S., 1977, The Biology and Morphology of Pteridophytes, Central Book Depot,	

Allahabad.

6. Rashid, A. 1999, An Introduction to Pteridophyta, Vikas Publishers, New Delhi.
7. Sporne, K.R. 1965, The Morphology of Pteridophytes, B.I. Publications Pvt. Ltd., Delhi.

This course can be opted as an elective by the students of following subjects: NA

Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: None		
Programme: M.Sc./M.A.	Year: I	Semester: I
Subject: Statistics		
Course Code: <i>PGBR-01</i>	Course Title: <i>Basics in Research</i>	
Course Objectives: The main objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods, survey, Plagiarism and copyright issue.		
Course Outcomes: CO1: To write a good qualitative research statement and design the research questions. CO2: To know about the hypothesis, conduct the survey and a qualitative case study. CO3: Able to know the Plagism and copyright issue for writing research paper and project.		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
BLOCK 1	Basic of Research	
Unit 1	Introduction to Research: Knowledge and the Approaches of Acquiring knowledge (deductive, inductive and scientific), Meaning of Research, Objectives of Research, Motivation in Research, Significance of Research, Importance of knowing How Research is Done?, Criteria of Good Research	
Unit 2	APPROACHES OF RESEARCH: Types of Research, Research Approaches, Research Methods versus Methodology, Research and Scientific Method, Research Process	
Unit 3	DEFINING THE RESEARCH PROBLEM: What is a Research Problem?, Selecting the Problem, Necessity of Defining the Problem, Technique involved in Defining a Research Problem.	
Unit 4	RESEARCH DESIGN: Need for Research Design, Features of Good Design, Important Concepts Relating to Research Design, Different Research Design, Basic Principles of Experimental Designs.	
BLOCK 2	LITERATURE SURVEY, REVIEW, AND SYNOPSIS PREPARATION	
Unit 5	Literature Survey: Introductions: Sources of information, need for reviewing literature, primary-secondary and tertiary sources, journals, abstracts, text books, Web resources, E-journals, journal access, case study alerts. Citation index, UGC infonet, E-books, Impact Factors, Search engines- Google scholar, Science Direct, SciFinder, Scopus, web of science.	
Unit 6	Literature Review: Establishing the Context, Identifying Gaps in Knowledge, Formulating Research Questions or Hypotheses, Defining Key Concepts and Terms, Selecting Research Methods, Supporting Research Design and Methodology, Evaluating Research Methods, Citing Relevant Studies, Avoiding Redundancy, Synthesizing Knowledge, Demonstrating Scholarly Engagement, Guiding the Organization of Your Research Paper, Providing a Theoretical Framework, Supporting Ethical Research, Contributing to the Research Conversation, Types of Review of literature.	
Unit 7	Preparation of Research Synopsis: The structure of synopsis- Title, Introduction, Literature	

	Review, Research Questions or Hypotheses, Methodology, Data Collection, Data Analysis, Expected Outcomes and Significance, Timeline, References, Budget, Appendices.
BLOCK 3	ETHICS AND IPR
Unit 8	Research Ethics: Regulatory bodies, practices and compliances, Good Laboratory Practices (GLP), Research Ethics & Misconduct.
Unit 9	Intellectual Property Rights: Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties. Plagiarism, Patents, Fundamentals of patents, Product and process patent, Patent Treaties and Convention, process of filing patent (Search and retrieval), copyrights, geographical indications, design and layout, trademarks.
Unit 10	Ethical consideration for research: Informed Consent, Privacy and Confidentiality, Minimizing Harm and Risks, Beneficence, Justice and Fairness, Deception, Publication Ethics, Peer Review, Conflict of Interest, Animal Welfare, Data Management and Sharing, Community and Stakeholder Involvement, International Research Ethics.
BLOCK 4	RESEARCH REFERENCE, REPORT AND PAPER WRITING
Unit11	Reference Writing: APA Style (American Psychological Association), MLA Style (Modern Language Association), Chicago Style, IEEE Style (Institute of Electrical and Electronics Engineers), AMA Style (American Medical Association), Harvard Style, Vancouver Style, Turabian Style, CSE Style (Council of Science Editors), Bluebook Style. Tips for writing references.
Unit12	Report writing in academics and research: Various kinds' of academic and research activities. Necessity of report writing for achievement of academic and research goals. Various kinds of reports / presentations. Characteristics of academic and research reports / presentations. Conclusions. Scientific Writing – Introduction to Technical writing, definition, types, characteristics, Report Writing, Research proposal writing.
Unit13	Research paper writing: Choose a Topic, Conduct a Literature Review, Formulate a Research Question or Hypothesis, Plan Your Research, Gather Data, Organize Your Research, Write an Outline, Write the Introduction, Literature Review, Methodology, Results, Discussion, Conclusion, Cite Your Sources, Proofread and Edit, Formatting and References, Finding a Suitable Journal, Submit Your Paper, Peer Review and Revision, Final Proofreading.
Block 5	RESEARCH TOOLS AND STATISTICAL METHODS
Unit 14	Basics of Data, Research Tools, and Types of Variables- Research Tools for Data Collection- Questionnaire , Structured vs. Semi-structured, Open-ended and closed-ended questions, Interview Schedule -Face-to-face, telephonic, or digital, Observation Method , Participant and non-participant observation- Checklist and Rating Scale , Likert scales, semantic differential scales, Dietary Assessment Tools , 24-hour recall, food frequency questionnaire (FFQ), food diary, Anthropometric Measurement Tools , Weighing scale, stadiometer, measuring tape,

	MUAC, BMI chart. Types of Data and Variables -Qualitative vs. Quantitative, Nominal, Ordinal, Interval, Ratio, Dependent and Independent Variables. Understanding Data Distributions -Normal and skewed distributions, checking normality: Histogram, Q-Q Plot, Shapiro-Wilk test.
Unit 15	Parametric Statistical Tools and Applications - Descriptive Statistics (Parametric), Mean, Median, Mode, Standard Deviation, Variance, Percentiles and Z-scores, Inferential Parametric Tests, t-tests , One-sample t-test, Independent samples t-test, Paired samples t-test, One-way ANOVA , F-test, post-hoc interpretation, Correlation and Regression , Pearson correlation, Simple Linear Regression (assumptions, interpretation, R^2), Confidence Intervals and p-values , Interpretation and significance, Tools Used : MS Excel, SPSS, Examples : Comparing mean hemoglobin between groups, Predicting BMI from daily calorie intake.
Unit 16	Non-Parametric Statistics and Risk Estimation Tools -Descriptive Statistics (Non-Parametric), Median, Mode, Interquartile Range, Non-Parametric Tests , Chi-square Test, Test of independence using contingency tables, Mann-Whitney U Test , Comparison of two independent groups, Wilcoxon Signed-Rank Test , Paired samples, Kruskal-Wallis Test , Non-parametric ANOVA alternative, Risk Estimation Tools , Odds Ratio (OR), Use in case-control studies, Interpretation, Relative Risk (RR) , Use in cohort studies, 2x2 tables, Manual and SPSS calculation, Tools Used : SPSS, Manual calculation using examples, Examples : Association between junk food and obesity, Risk of anemia based on dietary habits.
Suggested Text Book Readings: 1. C.R. Kothari, Gaurav Garg. Research Methodology: Methods and Techniques, New Age International Publishers, 2019. 2. Kumar. R: Research Methodology: A Step-by-Step Guide for Beginners, (3rd Edition), SAGE, Inc., 2011. 3. https://onlinecourses.swayam2.ac.in/cec22_ge28/preview	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: I	Semester: II
Subject: Botany		
Course Code: PGBY-106 (N)	Course Title: Gymnosperms and Palaeobotany	
Course Objectives: The aim of this course is to familiarize the students general introduction of gymnosperms and their similarities and dissimilarities with pteridophytes and angiosperms.		
Course Outcomes:(CO): On successful completion of this course, the students will be able to know: • General account of various orders and families of cycadopsida and coniferopsida. • Introduction and application paleobotany • Types of fossils and their preservation.		
Credits: 04	Type of Course: Core (√) /Elective	
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	General Account of Gymnosperms & Cycadopsida	
Unit I	General Introduction	

	General introduction of gymnosperms with special reference to its Salient features, similarities and dissimilarities with pteridophytes and angiosperms and classification of gymnosperms, origin and evolution of gymnosperms from progymnosperms. Origin of seed. Economic importance of Gymnosperms.
Unit II	CYCADOPSIDA-I Morphological, anatomical and structural variations, phylogeny, affinities and interrelationship within families of various orders- a) Pteridospermales- families- (i) Lyginopteridaceae; (ii) Medullosaceae; (iii) Glossopteridaceae; (iv) Corystospermaceae; (v) Peltaspermaceae; (vi) Caytoniaceae. b) Cycadales- General account; Geographical distribution; Evolutionary tendencies c) Nilssoniales- A general account
Unit III	CYCADOPSIDA-II a) Bennettitales (Cycadeoideales)- General account affinities and interrelationships among the families (i) Williamsoniaceae; (ii) Woeamdoeaceae (iii) Cycadeoideaceae b) Pentoxylales- General account; Evolutionary tendencies
Block 2	Coniferopsida
Unit IV	Cordiales A General account of the order with reference to families (i) Eristophylaceae; (ii) Cordaitaceae (iii) Poroxylaceae
Unit V	Ginkgoales- A General account of Ginkgoaceae Family.
Unit VI	Coniferales - I Distribution of conifers with special reference to India. Evolutionary trends, evolution of megastrobilus and seed-scale complex in various families. Study of various fossil genera, their reported structures with reference to some important families- (i) Lebachiaceae (ii) Voltziaceae (iii) Palissyaceae
Unit VII	Coniferales - II Comparative morphological anatomical and reproductive studies in living genera with reference to families- (i) Pinaceae (ii) Araucariaceae (iii) Taxodiaceae
Unit VIII	Coniferales - III

	Comparative morphological anatomical and reproductive studies in living genera with reference to families- (iv) Cupressaceae (v) Cephalotaxaceae (vi) Podocarpaceae.
Unit IX	Taxales Comparative account of genera- <i>Taxus</i>, <i>Torreya</i>, <i>Palaeotaxus</i>, <i>Autrotaxus</i>, <i>Pseudotaxus</i>, <i>Amentotaxus</i>
Block 3	Gnetopsida & Palaeobotany
Unit-X	Polarity A general comparative account with reference to <i>Ephedra</i>, <i>Gnetopsida</i> and <i>Welwitschia</i>.
Unit-XI	Palaeobotany-I Introduction, techniques of study fossil, Geological time scale. Application of paleobotany.
Unit-XII	Palaeobotany-II Types of fossils- their methods of preservation, form- genera; Organ- genera, Reconstruction of fossil
Suggested Text Book Readings: - Chamberlain, Charles Joseph, b.(1863), <i>Gymnosperm; Structure and Evolution</i>. Chicago, Ill., The University of Chicago Press - Chhaya Biswas and B.M.Johri. <i>The Gymnosperm</i>. Springer; 1997, edition (16 April 2014) - Pant DD. (2002), <i>An Introduction to Gymnosperms, Cycas, and Cycadales</i>, Birbal Sahni Institute of Palaeobotany. - Steward W.N., <i>Palaeobotany and evolution of plant</i>. Cambridge University Press, New York.405 p.(1) - Stewart, W.N., and G.W.Rothwell.(1993) <i>Palaeobotany and the evolution of plant</i>. 2nd ed. Cambridge University Press, New York.521 p.(1)	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: I	Semester: II
Subject: Botany		
Course Code: PGBY-107 (N)	Course Title: Anatomy, Reproduction and Morphogenesis	
Course Objectives: To know the various structural and anatomical components of the plant tissue, reproductive parts of the plant and phenomenon of morphogenesis in plants.		
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Know about plants anatomical structure, their development patterns. • Normal and abnormal secondary growth in plant. • Plant reproductive parts development of male and female gametophyte, fertilization and post fertilization changes. • How morphogenesis occurs in plants.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	

(Syllabi should be framed block wise/unit wise; No of blocks and units may change)	
Block 1	Anatomy
Unit I	Root and Shoot Organization - Root: organization of RAM (Root apical meristem), cell fates, Differentiations of vascular tissue, formation of aerial roots, root hairs. - Shoot: Cytological analysis of SAM (Shoot apical meristem), Growth and differentiation of shoot.
Unit II	Tissue - Tissue differentiation: Cambium, Xylem, Phloem their function, factors and development. - Root-Shoot Transition: Origin, differentiation and growth: leaf, Mesophyll, Epidermis (including cuticle, stomata and trichomes) and Venation.
Unit III	Secretory Tissue - Secretory ducts, Laticifers: Structure and Formation - Plant Surface- Structure and Function of Lenticels, Hydathodes, Epiphyllous branches, Epicuticulate waxes, Extra floral nectaries and Hydrotropes
Unit IV	Anomalous secondary growth: Vascular cambium and its derivatives, primary anomalies in stem and anomalous secondary growth floral morphology and anatomy, fruit and seeds, periderm, wood structure, Sapwood and Heart wood, growth rings.
Block 2	Reproduction
Unit V	Microsporogenesis: Structure, development, function; Microsporogenesis, Male gametophyte
Unit VI	Megasporangium (Ovule): - Types, Evolution and ontogeny: Megasporogenesis: organization of embryo sac, Gene function during Megagametogenesis. - Sexual incompatibility; methods of overcome; barriers to fertilization, pollen tube; structure and growth, sexual dioecism.
Unit VII	Fertilization and Post Fertilization Changes Double fertilization, Post fertilization structural changes in embryo sac: Endosperm: structure, development: polyploidy in reproductive organs and tissues
Unit VIII	Embryogenesis and Polyembryony Embryogenesis; Physiological and morphogenetical relationship of endosperm and embryo. Polyembryony, Apomixis: Classification, causes and application
Unit IX	Structure and growth of fruit and seed. Experimental and applied embryology.
Block-3	Morphogenesis
Unit X	Morphogenetic phenomenon: Symmetry and polarity, concepts of cell differentiation and totipotency
Unit XI	Tissue Culture – I Plant cell and tissue culture: General introduction, history and scope; Tissue culture techniques and culture media; Experimental embryology, anther, ovary and endosperm culture; somatic embryogenesis and androgenesis
Unit XII	Tissue Culture – II Somatic hybridization and application of tissue culture: Protoplast isolation, culture and regression, Somatic hybridization and hybrid selection; possibilities, achievements and limitations of protoplast research; Applications

	of plant tissues culture: clonal propagation, artificial (Synthetic) seed, production of hybrids and soma clones, production of secondary metabolites/natural products; Cryopreservation and germplasm storage.
Suggested Text Book Readings:	
1. Cutter, Elizabeth (1969), Plant Anatomy part –I Cells and Tissues IInd edition,Edward Arnold,London 2. Cutter, Elizabeth (1971), Plant Anatomy Part- II Organs ,Edward Arnold London 3. Eames, A. J. & Mac Daniels Laurence H. (1951), An Introduction To Plant Anatomy, Mc Graw Hill. 4. Eames A.J (1961), Morphology of Angiosperms,Mc Graw-Hill,New York. 5. Bhojwani, S.S. and Bhatnagar, S.P.(1985), Embryology of Angiosperms, Vikash Publishing House, New Delhi 6. Johri, B.M (1984) Embryology of Angiosperms.Springer-Verlog Berlin Heidelberg. 7. Maheshwari, P. (1950) An Introduction to the Embryology of Angiosperms.Tata McGraw Hill. 8. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: I	Semester: II
Subject: Botany		
Course Code: PGBY-108(N)	Course Title: Taxonomy of Angiosperm and Economic Botany	
Course Objectives: This course aims to educate students on concept of systematics, taxonomic keys, classification of flowering plants and important families of dicots and monocots and economic importance of diverse plants that offer resources to human life.		
Course Outcomes: (CO): On successful completion of this course, the students will be able to: • Acquaint nomenclature, systematics, taxonomic evidences and description of important families of dicots and monocots • Learn about the different types of bioresources e.g., in service of mankind (as medicine, as food, as timber, as fibre and dye yielding plants,) • Learn about various beverage plants and gums. • Develop the ability of students about determining the property of spices and condiments.		

Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100		Min. Passing Marks: 36
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Taxonomy of Angiosperm	
Unit I	Taxonomy of Angiosperm-I Latin diagnosis, definition and use of taxonomic terms, history of plant taxonomy in India, history of plant classification, needs and aim of classification, units of classification, delimitation of taxa and their practical consideration, artificial, natural and phylogenetic system of classification. A critical study of Takhtajan's, modern system of classification, an introduction of angiosperm phylogeny group (APG), characteristics and phylogeny of orders	
Unit II	Taxonomy of Angiosperm-II Needs and aim of nomenclatures, International code of Botanical Nomenclature, Concept of species genus, family with special reference to the type concept. Interrelationship of plant taxonomy with morphology, anatomy, embryology, palynology, cytology, genetics, phytogeography and chemistry, A general survey of recent advances in taxonomy: Biosystematics, biochemical and molecular systematic and numerical taxonomy.	
Unit III	Taxonomy of Angiosperm-III Indigenous flora of the country with special reference of local flora (Uttar Pradesh), A general knowledge of Herbarium and Botanical garden of the world and India, organization of Botanical survey of India and its role.	
Unit IV	Taxonomy of Angiosperm-IV - Interesting taxonomic feature and interrelationships of following Dicot and Monocot families: Dicots: Acanthaceae, Amaranthaceae, Asteraceae, Caesalpiniaceae, Capparaceae, Caryophyllaceae, Casurinaceae, Curcubitaceae, Euphorbiaceae, Malvaceae, Mimosaceae, Papaveraceae, Papilionaceae, Polygonaceae, Ranunculaceae, Rosaceae, Rubiaceae, Scrophulariaceae	
Unit V	Monocots: Arecaceae, Cyperaceae, Liliaceae, Orchidaceae, Poaceae and Zingiberaceae.	
Block 2	Ecology-II	
Unit VI	Cereals Origin, cultivation and improvement of major crops viz. Wheat, Rice, Maize, Pearl Millet and Sorghum.	
Unit VII	Pulses General account of pulses along with their economic uses.	
Unit VIII	Sugars and Starches Sugars (Sugarcane, potato, Sweet potato); Starches (Potato)	
Unit IX	Fibers Extraction and utility of fibers (cotton, jute, Coir and paper making fibers)	
Unit X	Oils & Rubbers Essential and non essential oils, extraction of rubber and their uses.	
Unit XI	Species, Condiments, Fumatories & Masticatories	

	Morphological identification & pharmacognosy anatomical characterization of species & Condiments, Fumatories & Masticatories
Unit XII	Forest Products- Wood and Cork Major woods, medicinal plants, petrocrops and beverages.
Suggested Text Book Readings: - Hill, A.F., 1952, Economic Botany (2nd Ed.), McGraw Hill, New York. - Kochar, S.I., 1981, Economic Botany in the Tropics, Macmillan India Ltd., New Delhi. - Simpson B.B. and Ogorzaly M.C., 2001, Economic Botany: Plants of our world (3rd ed.), McGraw Hill, New York, USA - Simpson, M.G., 2010, Plant Systematics, Elsevier, Amsterdam. - Steussy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S., 2014, Plant Systematics: The Page64 origin, interpretation, and ordering, of plant biodiversity, Koeltz Scientific Books, Konigstein, Germany. - Radford, A.F., 1986, Fundamentals of Plant Systematics, Harper and Row Publishers, Inc.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: None		
Programme: M.Sc./M.A.		Year: I
Subject: Mathematics		
Course Code: PGED-02		Course Title: Entrepreneurship Development
Credits: 4		Type of Course: Core
Max. Marks: 100		Min. Passing Marks: 36
Unit 1	Entrepreneurship Introduction, Meaning, Evolution & Concept Of Entrepreneurship, Nature Of Entrepreneurship, Importance Of Entrepreneurship, Elements Of Entrepreneurship Characteristics Of Entrepreneurship, Need Of Entrepreneurship, Functions Of Entrepreneurship Types Of Entrepreneurship, Merits Of Entrepreneurship, Demerits Of Entrepreneurship, Entrepreneurship And Environment The Need Of Entrepreneurship For Indian Economy ,Introduction, Views Of Leading Thinkers, Drucker's Views On Entrepreneur Walker's Views On Entrepreneur.	
Unit 2	Entrepreneur Meaning, Concept, Characteristics Of An Entrepreneur Qualities Of Entrepreneur, Difference Between Entrepreneurship And Entrepreneur, Difference Between Entrepreneur, Intrapreneur And Manager, Difference Between Entrepreneurship And Intrapreneurship	
Unit 3	Functions And Types Of Entrepreneur Introduction, Basic Functions Of An Entrepreneur, Process To Setup An Enterprise, Difference Between Managerial Functions And Entrepreneurial Functions Of An Entrepreneur, Types Of Entrepreneurs,	

Unit 4	Theories Of Entrepreneurship Introduction, Economic Theories, Neoclassical Economic Theories Of Entrepreneurship , Sociological Theories Of Entrepreneurship, Psychological Theories Of Entrepreneurship, Cultural Theories Of Entrepreneurship
Unit 5	Entrepreneurship Development Programme: Introduction, Evolution And Concept Of Entrepreneurship Development Programme , Meaning, Features Of Entrepreneurship Development Programme , Need Of Entrepreneurship Development Programme , Objectives Of Entrepreneurship Development Programme , Formulation Of Entrepreneurship Development Programme , Outline Of Entrepreneurship Development Programme , Achievements Of Entrepreneurship Development Programme
Unit 6	Entrepreneurship Development In India: Meaning, Sustainable Entrepreneurship Development, Phases Of Entrepreneurship Development In India, Emergence Of Entrepreneurial Class In India, Locational Mobility Of Entrepreneurs, The Key Factors Influencing The Mobility Of Entrepreneurs , Entrepreneurial Performance In India, Entrepreneurship Development Cycle, Institutions For Entrepreneurship Development
Unit 7	Women Entrepreneurship: Introduction, Meaning, Characteristics Of Women Entrepreneurship, Factors Affecting The Need For Women Entrepreneurship, Problems Of Women Entrepreneurs, Remedies/ Overcoming/Solutions To The Problems Of Women Entrepreneurs, Steps To Promote Women Entrepreneurs, Traits Of Successful Women, Benefits Of Women Entrepreneurship
Unit 8	Promotion Of Ventures: Meaning And Concept Of Projects, Characteristics Of Project, Types Of Projects, The Boundaries Of A Project, Project Life Cycle – Stages, Success Of A Project, Implementation Of A Project, Benefits Of Project Management, Project Management, .Task Management, Difference Between Task Management And Project Management , Uses Of Project Management And Task Management, Project Identification, Identification Stage Diagram, Formulation And Report, Project Appraisal, Product Selection And Technique, Criteria And Factors To Be Considered In New Product Selection Stages, Phases Involved In New Product Selection Exercise
Unit 9	Project Management: Introduction, Meaning And Concept Of A Project, Characteristics Of A Project, Importance Of Project Management, Tools And Techniques Of Project Management, Classification Of Project, Project Life Cycle And Its Phases, The Project Manager, Roles And Responsibilities Of Project Manager
Unit 10	Raising Funds: Introduction, Concept & Relevance Of Finance For The Entrepreneur, Choices Between Sources Of Financial Capital, Sources Of Funds, The Advantages And Disadvantages Of The Different Sources Of Finance, Steps In Managing Finance, Objectives Of Financial Planning For The Entrepreneur
Unit 11	Legal Requirements For Establishment Of New Business Unit: Introduction, Formalizing A Business Structure And Founders Agreement, . Applying For Business Licenses, Understanding Taxation And Accounting Laws. Adhering To Labour Law. Ensuring Protection Of Intellectual Property. Ensuring Effective Contract Management. Details About Winding Down The Business
Unit12	Financial Institution's Aid To Entrepreneurs Introduction, Assistance Of Financial Institutions To Entrepreneurs, Comprehensive Promotion Structure Of MSME Sector, Financial Institutions Supporting And Assisting Small Scale Industries (SSI) In India
Unit13	Network Analysis Meaning And Concept Of Network Analysis, Importance Of Network Analysis/Network Technique, Classification Of Network Techniques, Programme

	Evaluation And Review Technique (PERT), Procedure Followed In PERT ,Advantages Of Pert ,Limitations Of Pert ,Critical Path Method (CPM): ,Identification Of The Critical Path, Advantages Of Critical Path Method ,Limitations Of CPM ,Similarities Between Pert And CPM, Comparison Between Pert And CPM ,Differences Between PERT And CPM Financial Support System: Forms of Financial support, Long term and Short term financial support, Sources of Financial support, Development Financial Institutions, Investment Institutions
Unit14	Marketing Assistance To Entrepreneurs Introduction, Meaning, Types Of Markets Available To An Entrepreneur, Traditional Marketing, Entrepreneurial Marketing, Differences Between Traditional And Entrepreneurial Marketing
Unit15	Entrepreneurship Development: Intellectual Property Rights And MSME Introduction, IPR And MSME's, Patents ,The Patent Process, Types Of Patents, Who Can File For A Patent?, Trademarks, Types Of Trademarks, Registration Of Trademark, Copyrights ,Objectives Of Copyrights, Geographical Indications ,Industrial Designs ,Trade Secrets ,Integrated Circuits, Protection Of New Plant Variety, Need Of IPR For MSME
Unit16	Small Business Introduction, Meaning Of Small Business, Types Of Small Business, Nature Of Small Business, Characteristics Of Small Business Enterprises, Objectives Of Small Business, Importance Of Small Business, Process Of Establishing Small Business,
Unit 17	Project Budgeting/Capital Budgeting Introduction, Meaning And Definition Of Project/Capital Budgeting, Features Of Capital Budgeting, Importance And Need Of Capital Budgeting, Types Of Capital Expenditure, Factors Affecting Capital Investment Decisions
Unit 18	Project Control Introduction, Control Process, Scope Of Project Control, Techniques Of Schedule Control ,Techniques Of Cost Control
Unit 19	Entrepreneurial Consultancy Meaning, Entrepreneurial Consultancy: Process And Methods, Motives Or Reasons For Using Advisory Services, Approaches To Modern Counselling, Marketing Counselling
Unit 20	E Commerce And Entrepreneurship Introduction, Meaning And Concept Of E-Commerce , Approaches Of E-Commerce , Relevance Of E-Commerce , Advantages Of E-Commerce, Disadvantages Of E-Commerce, Difference Between Traditional Commerce And E-Commerce
Unit 21	Planning Of Capital Structure Introduction, Meaning Of Capital Structure, Types Of Capital Structure, Importance Of Capital Structure, Factors Determining Capital Structure, Capital Gearing, Planning Of Capital Structure, Optimal Capital Structure, Determinants Of Capital Structure
Suggested Text Book Readings: 1. <u>C.R. Kothari, Gaurav Garg. Research Methodology: Methods and Techniques, New Age International Publishers, 2019.</u> 2. Kumar, R: Research Methodology: A Step-by-Step Guide for Beginners, (3rd Edition), SAGE, Inc., 2011. 3. https://onlinecourses.swayam2.ac.in/cec22_ge28/preview	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: III
Subject: Botany		
Course Code: PGBY-111 (N)	Course Title: Environmental Botany	
Course Objectives: The aim of this course is to give the students essential knowledge about basic concepts of plant ecology especially of structure of ecosystem, different niches, community, different energy flow pathways, biogeochemical cycles, population properties and ecological succession.		
Course Outcomes:(CO) : On successful completion of this course, the students will be able to: • Understand mechanisms by which organisms interact with other organisms and with their physical environment. • Develop insights about the concepts of populations, community and ecosystems and can use in management of natural resources for sustainable development. • Acquire knowledge about limiting factors controlling distribution and growth of organisms. Comprehend interactions among components of ecosystems for better stability. • Describe biotic and abiotic factors that influence the dynamics of populations.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks:100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Environmental Botany-I	
Unit I	Introduction to ecology, and environmental terminology, population dynamics, vegetation organization and development: population characteristics, population growth forms, density dependent and density independent controls, population structure (distribution, aggregation, isolation territoriality) energy partitioning, r - and k-selection, concept of carrying capacity; Wild life sanctuaries, botanical gardens	
Unit II	Climate Factors • Environmental complex; Interaction of ecological factors; Light factor; Temperature factor; Precipitation (rain fall); Humidity of air; Atmosphere-Gases and wind; Atmospheric gases; Wind factor; Fire factor.	
Unit III	Ecological Adaptations • Forms of water in nature; Adaptations of land plants- water balance problems; Ecological groups of plants-ecological adaptations; Hydrophytes; Ecological adaptations in hydrophytes; Mesophytes; Ecological adaptations in xerophytes; Halophytes.	
Unit IV	Concepts of Community • Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, competition,	

	ecological niche, succession, mechanism of ecological succession (relay floristic and initial floristic composition facilitation, tolerance and inhibition models), concept of climax
Unit V	Ecosystem: Ecosystem organization, structure and function: primary production (methods of measurement), energy dynamics (tropic organization, energy flow pathway, energy quality, ecological efficiencies), biogeochemical cycles
Block 2	Environmental Botany-II
Unit VI	Environmental impact assessment, threatened and endangered plant species, role of diversity in ecosystem stability, general account of remote sensing and its application, sustainable development. Major terrestrial biomes, biogeographical area of India, major vegetation.
Unit VII	Environmental Pollution Environmental Pollution, the problem and its causes and prevention (Air, water, and soil, radioactivity and noise). Modern Environmental problems- Acid rain, Ozone depletion, green house effect and Climate
Unit VIII	Environmental Management, Act and Polices: Environmental appraisal, environmental impact statement (EIS) environmental plan (EMP), Environmental audit, sustainable development, Environmental laws and protection act 1986, The water act 1974, The air act 1981, wildlife act 1972, Guidelines and polices for control of noise, loss of biodiversity, solid and hazardous waste management handling the management rules.
Unit IX	Climate and Vegetation of India Climate of India; Climate Regions of India; Flora and Vegetation of India; Grasslands of India; Forests of India; Tropical Wet Evergreen Forests; Tropical Semi-evergreen Forests; Tropical Moist Deciduous Forests; Littoral Forests; Tidal and Freshwater Swamp Forests; Tropical Dry Deciduous Forests; Tropical Dry Evergreen Forests; Sub-tropical Pine Forests; Sub-tropical Dry Evergreen Forests; Montane Wet Temperate Forests; Himalayan Moist Temperate Forests; Himalayan Dry Temperate Forests; Sub-alpine Forests; Alpine Scrub; Vegetation of Delhi.
Unit X	Biotic Factor Relationships among organisms; Positive interactions; Negative Interactions; Microclimate.
Unit XI	Soil: Soil and natural medium for plant growth. Origin of soil, Minerals as a source of plant nutrients. Soil forming process and its impact on soil profile development, properties of soils, Soil texture & structure, Ion exchange, calcareousness, salinity, sodicity. Organic matter
Unit XII	Soil fertility: Concept, basic methods of fertility evaluation and maintenance. Soil types of India.
Suggested Text Book Readings: - Chapman, J.L. and Reiss, M.J. 1998, Ecology Principles and Applications (2nd Edition), Cambridge University Press, U.K. - Odum, E.P. and Barrett, G.W., 2005, Fundamentals of Ecology, Thomson Books/Cole,	

U.S.A.
3. Sharma, P.D., 2011, Ecology and Environment, Rastogi Publ. Meerut.
4. Singh, J.S., Singh, S.P. and Gupta, S.R., 2006, Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
This course can be opted as an elective by the students of following subjects: NA
Suggested equivalent online courses (MOOCs) for credit transfer: NA

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: III
Subject: Botany		
Course Code: PGBY-112 (N)	Course Title: Plant Physiology and Biochemistry	
Course Objectives: The aim of this course is to give the students essential knowledge pertaining to plant physiology especially the water transport, absorption, photosynthesis, respiration and nitrogen metabolism.		
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Know about carbon fixing pathways, oxidative pathways. • Enhance knowledge of students about nitrogen fixation and translocation of water and minerals. • Know structure and role of amino acids and proteins their biosynthesis and their modification into specific structure. • Gain the knowledge on nucleic acids, their synthesis and regulation, fatty acids their types and synthesis.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Plant Physiology-I	
Unit I	Plant water relations: • Transport and translocation of water and solutes, water potential and components, mechanism of water transport, mineral nutrition, nutrient uptake, solute transport, phloem loading and unloading.	
Unit II	Minerals and their uptake: • Essential elements, methods of studying nutrients requirement, Hydroponics, Macronutrients, Micronutrients, Toxic effects of minerals, site of minerals uptake, Mechanism of uptake, Factors affecting minerals uptake, Foliar uptake of minerals.	
Unit III	Photosynthesis-I • Definition, Importance of photosynthesis, Historical account, Photosynthetic pigments, Nature of light and its absorption.	
Unit IV	Photosynthesis-II • Mechanism of photosynthesis, Light reaction, C3 cycle, C4 cycle, CAM cycle, C2 cycle.	
Block 2	Plant Physiology-II	
Unit V	Respiration:	

	Glycolysis, the TCA Cycle, electron transport and ATP synthesis, Pentose Phosphate pathway, Glyoxylate cycle.
Unit VI	Plant Growth Regulators: Structure, metabolism and physiology effect of auxins, gibberellins, cytokinin, ethylene and abscisic acid.
Unit VII	Physiology of Floral Induction: Photoperiodism and its significance, role of Vernalization. Physiology of seed germination, Metabolic changes during seed germination, factors affecting seed germination and dormancy, breaking of dormancy.
Unit VIII	Sensory Photobiology: History and discovery of phytochromes and cryptochromes and their photochemical and biochemical properties, Photophysiology of light induced responses.
Unit IX	Nitrogen Metabolism Nitrogen metabolism, respiration and lipid metabolism: Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, Interaction of nitrogen assimilation with carbon metabolism. Glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, Cyanide resistant respiration, Lipid metabolism.
Block-III	Biochemistry
Unit X	Enzymes and Coenzymes Nomenclature and Classification, Physico-chemical Nature, Isolation and Purification of Enzymes, The Mechanism of Enzyme Action, Enzyme Kinetics, Factors Affecting Enzyme Activity, The Ribozymes, Zymogens, Coenzymes, Problems.
Unit XI	Proteins The Chemical Structure of Proteins, The Physical Configuration of Proteins, Determination of Amino Acid Composition of Proteins, Properties of Proteins, Biological Significance of Proteins, Glycoproteins.
Unit XII	Carbohydrates Monosaccharides, Oligosaccharides; Polysaccharides, Biological Significance of carbohydrates; Biosynthesis of Some Important Carbohydrates; Biological Oxidation of Carbohydrates.
Suggested Text Book Readings: - Hopkins, W.G. and Hüner, N.P.A., 2009, Introduction to Plant Physiology (4th Ed.) Wiley & Sons. Inc. USA. - Nelson, D. L., and Cox, M. M., 2017, Lehninger principles of biochemistry (7th Ed.). W.H. Freeman. - Salisbury, F.B. and Ross, C.W., 1992, Plant Physiology, (4th Ed.), Wadsworth Publishing Co. Belmont, California, USA. - Srivastava, L.M., 2006, Plant Growth and Development: Hormones and Environment, Academic Press, Published by Elsevier India Pvt. Ltd., New Delhi. - Taiz, L., Zeiger, et al., 2018, Fundamentals of plant physiology, Sinauer Associates.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: III
Subject: Botany		
Course Code: PGBY-113(N)	Course Title: Cytogenetics and Plant Breeding	
Course Objectives: The aim of this course is to give the students essential knowledge pertaining to biological processes such as DNA replication, transposition and mutations and various methods of breeding in plants reproducing sexually and asexually, and also importance of plant genetic resources in plant breeding.		
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Acquire knowledge about the different cytogenetic and molecular techniques used for genome analysis. • Linkage and recombination frequencies in gene mapping. • Have the knowledge of basics of mutations and their importance. • Understand the experimental steps and methods involved in generating new varieties using classical and contemporary breeding practices. • Spreads awareness about different aspects of plant breeding. • enhance knowledge in molecular breeding and cultivar development.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Cytogenetics	
Unit I	Cell Biology: • Cell structure and cellular organelles- Chloroplast, Mitochondria, Ribosome, Nucleolus, Nucleus, Plasma membrane, Endoplasmic-reticulum, Golgi-body, Lysosome	
Unit II	Chromosome Structure • Chromosome structure, nucleosome, solenoid and packaging of DNA, molecular organization of centromere and telomere, nucleolus, euchromatin and heterochromatin, karyotype analysis, banding patterns, special chromosomes-polytene chromosomes, lampbrush chromosomes, B chromosomes. Nucleic acids, Nuclear DNA content, C-value paradox, unique, moderately repetitive and highly repetitive DNA, conformation of nucleic acids (A, B, Z DNA), DNA sequencing and amplification Linkage and Recombination: Concept and Types of Linkage, Three point test crosses, Molecular mechanism of recombination.	
Unit III	Mendelian Inheritance and Interaction of Genes:	

	Mendelian inheritance and interaction of genes: Complementary, Epistasis, Inhibitory, Duplicate, Polymeric, Lethal and Additive interaction of genes. Cytoplasmic Inheritance: Cytoplasmic inheritance involving chloroplast (Mirabilis jalapa, Zea mays) and Mitochondria (petite yeasts and cytoplasmic male sterility in higher plants)
Unit IV	Quantitative Inheritance: Quantitative Inheritance: Continuous variation, Inheritance of quantitative traits like kernel colour in wheat, corolla length in Nicotiana, cob length in Zea mays. Population genetics: Gene and genotype frequencies, Hardy-Weinberg law, Factors affecting Hardy, Weinberg equilibrium
Unit V	Cell-Cycle Cell multiplication and turn over, cell cycle control mechanism, role of cyclins and ubiquitins, apoptosis Structural changes in chromosomes: Duplication, deficiency, inversion and translocation heterozygotes. Cytological consequences of crossing over in inversion and translocation heterozygotes. Numerical alterations in chromosomes: Origin of euploids and aneuploids, Production of autopolyploids, allopolyploids and haploids, Induction and characterization of trisomics and monosomics.
Unit VI	Mutation: Spontaneous and induced mutation, physical and chemical mutagens, molecular basis of mutations, transposable elements in prokaryotes and eukaryotes, site directed mutagenesis, DNA damage and repair mechanism.
Block 2	Plant Breeding
Unit VII	Importance and Achievements of Plant Breeding Importance, scope and major achievements of plant breeding. Germplasm; kinds of germplasm, collection, evaluation and organizations concerned with germplasm, in-situ and ex-situ conservation. Modes of reproduction in crop plants; sexual and asexual reproduction, apomixis, identification of apomictic plants. Incompatibility; genetic, physiological and biochemical basis of incompatibility, utility of self incompatibility. Male sterility; genetic and cytoplasmic male sterility and its applications.
Unit VIII	Methods of Breeding-I Plant introduction; types of introduction, procedure, uses of plant introduction and organizations associated with introduction. Pure line selection, mass and progeny selection, procedure and achievements. Pedigree selection, recurrent selection and their applications. Role of mutation in plant breeding, isolation of useful mutants and major achievements. Role of polyploidy in crop improvement.
Unit IX	Methods of Breeding-II Hybridization- kinds of hybridization, procedure of hybridization, types of hybridization and utility of hybridization. Hybrid

	breeding in self- and cross-pollinated crops. Back cross breeding Types of hybrids – single cross hybrid, three way cross hybrid, double cross hybrid, synthetic and composite crosses. Heterosis; theories of heterosis, inbreeding depression., Breeding for disease resistance.
Unit X	Salinity tolerance, variance and deviation.
Unit XI	Mutation Breeding: Definition, spontaneous and induced mutation, Artificial induced mutation, Gainma gardens, procedure of mutation breeding, application, limitation and advantages.
Unit XII	Improved seeds- its production, multiplication.
Suggested Text Book Readings: - Allard, R.W. (1960), Principles of Plant Breeding, John Wiley & Sons, N. York. - Chopra, E.I. (Ed.) (1989), Plant Breeding: Theory and Practice. (Reprint 1994), Oxford and HBH Publ. Co. New Delhi. - Singh, B.D., (2005), Plant Breeding – Principles and Methods, Kalyani Publishers, Ludhiana. - Alberts, B., and Johnson, A., 2016, Molecular Biology of Cell, Gerland Science Publisher. - Lodish, et. al., 2013, Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher. - Russell, P.J, 2006, Genetics (5th Ed.), Addison Wesley Longman, California, USA. - Snustad, P., and Simmons, M.J, 2011, Principles of Genetics. (6th Ed.), John Wiley, New York. - Robertis, EDP De & Robertis, EMF De, 2002, Cell and Molecular Biology (8th Edition), Lippincott Williams & Wilkins International Student Edition, Philadelphia.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: Basics in Research		
Programme: M.Sc./M.A.	Year: II	Semester: III
Subject: Statistics		
Course Code: PGRT-03		Course Title: <i>Basics Research Tools</i>
Course Objectives: The main objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of basic computer tools, research tools, indexing of research paper and scientific report writing.		
Course Outcomes:		
CO1: To know about the research tools and indexing of a research paper.		
CO2: To know about the fundamentals of basic computer tools and how to use it in research.		
CO3: Able to know the writing the research paper and scientific report writing.		
Credits: 4	Type of Course: Core	
Max. Marks: 100	Min. Passing Marks: 36	
Block 1	Introduction	
Unit 1	MEASURES OF CENTRAL TENDENCY MEASURES: Introduction, Definition. Objectives of Average .Characteristics of Good Average . Types of Average. Arithmetic Mean. Weighted Arithmetic Average .Median .Mode .Geometric Mean .Harmonic Mean	
Unit 2	MEASURES OF DISPERSION: Introduction. Definition .Objectives of Measuring Dispersion. Different Measures of Dispersion. Range .Standard Deviation . Lorenz Curve . Skewness . Kurtosis	
Block 2	PROBABILITY	
Unit 3	PROBABILITY – 1: Introduction . Meaning and Definition of Probability. Probability Defined. Experiment. Sample Space (S). Event. Types of events in probability. Probability Measure. Probability Rules:. Probability Theorems. Addition Theorem. Multiplication Theorem	
Unit 4	PROBABILITY 2: Conditional Theory. Key Concepts of conditional theory. Applications of conditional theory . Bayes' Theorem. Application of Bayes' Theorem. . Theoretical distribution . Uses of Theoretical Distributions. Types of Theoretical Distributions. Benefits Of Theoretical Distributions. Introduction. Binomial Distribution in Statistics . What Is The Binomial Distribution Formula?. Assumption For Binomial Distribution . Common Applications of Binomial Distribution. Poisson Distribution. Key Characteristics of Poisson distribution. Probability Mass Function (PMF). Applications of Poisson distribution. Assumptions of Poisson distribution. Common Uses of Poisson distribution. How to Solve Problems of Poisson distribution?	
Unit 5	PROBABILITY 3: Introduction;. Binomial Distribution in Statistics . What Is The Binomial Distribution Formula?. Assumption For Binomial Distribution . Common Applications of Binomial Distribution. Poisson Distribution, Key Characteristics of Poisson distribution, Probability Mass Function (PMF), Applications of Poisson distribution, Assumptions of Poisson distribution, Common Uses of Poisson distribution, How to Solve Problems of Poisson distribution?, Introduction, Key Characteristics of Normal Distribution, Properties of Normal Distribution, Application of Normal Distribution, Types of Normal Distribution	
Block 3	SAMPLING	
Unit 6	SAMPLING: Introduction: Meaning of Sampling, Need of Sampling, Advantages of Sampling, Limitations of Sampling	
Unit 7	SAMPLING METHODS OF DATA COLLECTION: Sampling, Data Collection,	

	Methods For Collecting Statistical Data , Types Of Data, Primary And Secondary Data, Primary Data, Secondary Data
Unit 8	SAMPLING DISTRIBUTION: Probability and Non-Probability Sampling, Sampling Techniques, Probability or Random Sampling, Simple Random Sampling, Stratified Sampling , Systematic Sampling , Cluster Sampling, Area Sampling, Probability-proportional-to-size sampling, Double Sampling and Multiphase Sampling, Non-probability or Non Random Sampling, Quota sampling, Convenience or Accidental sampling, Purposive (or judgment) Sampling, Snow-ball Sampling
Unit 9	SOURCES OF DATA COLLECTION: Introduction: Meaning and Importance of Data, Primary Sources of Data, Advantages of Primary Data, Disadvantages of Primary Data, Methods of Collecting Primary Data, Secondary Sources of Data, Features and Uses of Secondary Data, Advantages of Secondary Data, Disadvantages of Secondary Data, Methods of Collecting Secondary Data, Difference between Primary Data and Secondary Data, Questionnaire and Schedule Construction, Basic Rules for Questionnaire Item Construction
Block 4	STATISTICAL INVESTIGATION AND ESTIMATION
Unit 10	STATISTICAL ESTIMATION: Introduction, Point estimation , Types of point estimators , Properties of point estimator, Point estimation methods , Advantages of Point estimation:, Disadvantages of Point estimation , Errors in Point Estimation, Uses of Point Estimation , Interval estimation Types of Interval estimation, Properties of Interval estimation, Interval estimation methods , Advantages of Interval estimation, Disadvantages of Interval estimation, Errors in Interval estimation, Uses of Interval estimation
Unit 11	SAMPLING TEST: Introductions , Types of Sampling , Sampling Methods, Sampling Test Statistics: Hypothesis Testing:, Common Sampling Tests, Large sample, Benefits of Large sample, Limitation of Large Sample , Test for large sample , Some specific tests for large samples include , Small Sample , Benefits of Small Sample, Limitations of Small Sample, Types of Small Sample , Test For Small Sample
Unit 12	HYPOTHESIS TESTING: Introduction or Conceptual Framework of Hypothesis, Uses of Hypothesis, Scientific Hypothesis, Measures of Hypothesis, Statistical Hypothesis testing, Hypothesis Error
Unit 13	NON PARAMETRIC TEST: Non parametric test, Wilcoxon rank-sum test (Mann-Whitney U test), The Wilcoxon signed-rank test, The Kruskal-Wallis H test, Spearman's rank correlation, Chi-square test
Block 5	Statistical Tools
Unit 14	CORRELATION AND REGRESSION: Introduction, Definitions, Types of Correlation, Methods of Determining Correlation, Calculation of Coefficient of Correlation, Rank Correlation, Regression, Utility of Regression, Methods of Studying Regression, Regression Equation, Comparison of Correlation and Regression
Unit 15	STATISTICAL QUALITY CONTROL (SQC): Introduction, Key components of SQC, Benefits of SQC, Uses of SQC, Limitations of Statistical Quality Control, Functions of Statistical Quality Control
Unit 16	CONSTRUCTION OF CONTROL CHARTS: Introduction to Control Charts, Key Components of a Control Chart,How Control Charts Work, Types of Control Charts, Construction of Control Charts, Formula to calculate control chart,Control Chart Constants
Unit 17	CHI SQUARE TEST: Introduction, Chi-Square as Non-Parametric Test, Test of Goodness of Fit

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: IV
Subject: Botany		
Course Code: PGBY-116 (N)	Course Title: Applied Microbiology	
Course Objectives: The aim of this course is to familiarize students about application of microorganisms for the welfare of society.		
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Know microbes and their application in various fields. • Role of microbes in air, food, sewage, medicine and dairy industry. • Understand how microbes of soil increases fertility of soil. • Know how microbes of phyllosphere, rhizosphere and mycorrhizae helps the crop.		
Credits: 04		Type of Course: Core (√) /Elective
Category of Course (Please mention category of course; It may have more than one option)		Awareness/ life skills / soft skills/ value-added / employability/ entrepreneurship/ skill development/ MOOCs or OER
Max. Marks: 100		Min. Passing Marks:36
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Applied Microbiology-I	
Unit I	Introduction to Microbiology • Introduction to microbiology, history and scope of microbiology, tools and techniques used in microbiology laboratory, Microbial evolution, Systematics and taxonomy of microorganisms. Primitive organisms, their metabolic strategies and molecular coding. Microbes of the extreme environment and their metabolic strategies. The microbial cell: general organization of cell and cell wall of prokaryotes, eukaryotes and Archaea, prokaryotic and eukaryotic cell structure and function.	
Unit II	Introduction and General Characteristics of Microbes • Introduction and general characteristics of Viruses, bacteriophages, Plant Viruses– their morphology, taxonomy, reproduction and transmission, General account of Mycoplasma • Microbial nutrition, microbial growth, Gram negative and Gram positive bacteria, bacterial recombination and plasmids, Bacterial conjugation, DNA transformation, Transduction	
Unit III	Aero-microbiology • Microbiology of Air.	
Unit IV	Microbial Association-I • Mutualism (mycorrhizal), lichen Parasitism, Amensalism, Competition, Protocooperation, commensalism.	
Unit V	Microbial Association-II • Rhizosphere, Phyllosphere, Mycorrhizae, Actinorrhizae, Tripartite associations, PGPRs, microbes in agriculture	
Unit VI	Microbial Metabolism • Mutualism respiration, Fermentation and Microbial photosynthesis	
Block-2	Applied Microbiology-II	
Unit VII	Food Microbiology • Food Microbiology, food spoilage and preservation processes, microbiology of fermented foods, oriental foods, dairy foods, wine, beer and other fermented alcoholic beverages, bread and other fermented plant products, Microbial production of organic acids, antibiotics, amino acids, vitamins, recombinant products,	

	microorganisms as source of foods.
Unit VIII	Industrial Microbiology • Microbial production of organic acids, antibiotics, enzyme, vitamins, amino acid etc.
Unit IX	Agricultural Microbiology • Microbes: Plants Association, Rhizosphere, Phyllosphere, Mycorrhizae, Microbial biofertilizers and biopesticides, Microbial bioremediation of agricultural products, Biodegradation of pesticide.
Unit X	Sewage Microbiology • What is sewage, various process of treatment of sewage.
Unit XI	Soil Microbiology • Humus, Role of microbes in various cycles: Nitrogen, Carbon, Phosphorous and sulphur in soil.
Unit XII	Dairy microbiology • Composition of Milk of microbes of milk, Pasteurization of milk, Dairy products.
Suggested Text Book Readings: 1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganiss. 13th edition, Pearson Education Inc. 2. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan. 3. Atlas, RM. 1995. Principles of Microbiology. Mobsy. 4. Lim, DV. 2003. Microbiology. Kendall/Hunt. 5. Boundless.2013. Microbiology. Boundless Learning, Incorporated.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: IV
Subject: Botany		
Course Code: PGBY-117(N)/ 121 (N)	Course Title: Bioinformatics	
Course Objectives: This course has a strong interdisciplinary component and is designed to equip students with essential skills in bioinformatics (at basic level).		
Course Outcomes:(CO): On successful completion of this course, the students will be able to: • Get introduced to basic tools and concepts of Bioinformatics and their significance in applied and basic biology. They will also learn application of various bioinformatics tools, biodiversity databases and biological resources. • Learn about various biological databases and bioinformatics tools. • Learn about genome and model organisms. • Get introduced to gene prediction, phylogenetics and proteomic data analysis.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Basics of Bioinformatics	
Unit I	Introduction and scope of bioinformatics	
Unit II	Basics of computers (CPU, I/O units) and operating systems	
Unit III	Internet resources- • Internet, Concept of home pages and web-sites • World Wide Web, Uniform Resource Locators • Search engines and searching Internet for the information, NCBI, PubMed	
Block 2	Genome and Model organisms	
Unit IV	Functional genomics • Genome mapping- Genetic maps, DNA markers, RFLPs, SNPs, Linkage analysis, chromosomal maps, sequence Tagged sites (STS), and ESTs.	
Unit V	Study of Model organisms • <i>Caenorhabditis elegans</i>- life cycle, overview of genome • <i>Drosophila sp.</i>- life cycle, Polytene chromosome and overview of genome • Mouse- Overview of genome • Human- Overview of genome	
Block-III	Databases and Retrieval of Data	
Unit VI	Biological data bases • Contents, structure and annotation: Database in bioinformatics, primary and secondary databases • File formats • Annotated sequence database • Genome and organism-specific database • Life sciences databases • Database resources- GenBank, EMBL, SWISS-PROT, OMIM	
Unit VII	Retrieval of database • Data retrieval with Entrez and DBGET/ Link DB • Data retrieval with Sequence retrieval system (SRS)	
Unit VIII	Searching sequence data base • Sequence similarity searches	

	• Amino acid substitution matrices • Database searches- FASTA and BLAST Sequence filters
Unit IX	Name and Function of Database • DNA/ RNA databases • Protein sequence database, • Protein structure database • Protein domains and Motifs • Model organisms databases and resources
Unit X	Methods of gene prediction • Finding of gene, exons • Gene prediction programs and their examples • Gene prediction methods • Promoter recognition program and Pattern search
Unit XI	Phylogenetics • Phylogenetics, cladistics and ontology • Building phylogenetic trees • Evolution of macromolecular sequences
Unit XII	Proteomic data analysis • Analysing data from 2-D PAGE gels • Analysing protein mass spectrometry data
Suggested Text Book Readings: 1. Attwood, T.K. and Parry-Smith, D.J., 2004, Introduction to Bioinformatics, Pearson Education, Singapore, Pvt. Ltd. 2. Dwyer, R.A., 2004, Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press, 1st south Asian edition. 3. Edwards, D., 2007, Plant Bioinformatics: Methods and Protocols, Humana Press, new Jersey, USA.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: IV
Subject: Botany		
Course Code: PGBY-118 (N)	Course Title: Tools and Techniques	
Course Objectives: The aim of this course is to familiarize students about tools and techniques which will help them in scientific studies of the subject.		
Course Outcomes: (CO): On successful completion of this course students will be able to: • know analytical instruments and spectrometry • understand centrifugation, electrophoresis, chromatography & microscopy. • know auto radiography, micro-technique, micro-photometry, monometry and osmometry.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Toots and Technique-I	
Unit I	Analytical instruments- • Principal and applications of Balances Sorensen's PH scale PH meter-Calomel, glass and combined electrode	
Unit II	Spectrophotometry- • Principal and applications of Colorimeter- Lambert's Beer law Spectrophotometer- theory and instrument Nuclear magnetic resonance (NMR) Raman Spectroscopy.	
Unit III	Centrifugation Principle and type of centrifugations • Types of rotors and their uses Ultracentrifugation: Types and uses	
Unit IV	Electrophoresis- • Principles and applications of Gel Electrophoresis PAGE and SDS PAGE 2D- Gel Electrophoresis	
Unit V	Chromatography- • Principles and applications of Paper Chromatography Thin layer Chromatography High Performance Liquid Chromatography (HPLC)	
Unit VI	Microscopy- • Principles and applications of Light and Phase Contrast microscopy Dark field and Fluorescence microscopy Electron microscopy- TEM and SEM	
Block-2	Tools and Technique-II	
Unit VII	Autoradiography- • Principles and applications - Radioactivity, radioactive materials and their half-life Methods of autoradiography Applications with examples	
Unit VIII	Microbiological techniques • Media Preparation & sterilization Inoculation and growth monitoring Cell culture techniques	
Unit IX	Micro-technique – • Theory of fixation and important fixatives, storage of fixed materials, killing, Fixation, embedding and section cutting in serial, rocking and rotary microtomes, Stansand Dyes: Haematoxylin, safranin, fast-green and carmine, use of camera lucida, use of pH meter, oven, Incubator, autoclave and ultraviolet lamp.	
Unit X	Micro-photometry • Principle of micro-photometry Ocular and stage micrometers Calibration and measurements	

Unit XI	Manometry Types of manometer- • Piezometer, U-tube and advanced U-tube Measurement of Oxygen by manometer Warburg manometer
Unit XII	Osmometry • Vant Hoff s law of osmotic pressure Determination of osmotic pressure Types of osmometers and their applications
Suggested Text Book Readings: 1. Tools & Techniques in Biology by Umaiyal Munusamy. 2. Biological Tools & Techniques by Ananta Swargiary. 3. Life Science in tool and techniques by P.S. Bisen/ Shruti Mathur. 4. Techniques and methods in Biology by K.L. Ghatak	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc. with Botany		
Programme: M.Sc.	Year: II	Semester: IV
Subject: Botany		
Course Code: PGBY-120 (N)	Course Title: Plant Biotechnology Biosafety, IPR and History of Botany	
Course Objectives: The aim of this course is to give the students essential knowledge pertaining to Recombinant DNA Technology, DNA cloning, gene amplification, genetic transformation methods, IPRs biosafety and contribution of scientists in the field of botany		
Course Outcomes: (CO): On successful completion of this course, the students will be able to: • Understand various tools and techniques used in genetic engineering. • Demonstrate the strategies and measures for manipulation of genome by incorporating desirable genes pertaining to specific traits. • Acquire knowledge about different methods for genetic transformation of plants • Understand patent, copyright and trademark, the acts and policies in India and abroad. • Know the contribution of scientists in the different fields of botany.		
Credits: 04		Type of Course: Core (√) /Elective
Max. Marks: 100	Min. Passing Marks: 36	
(Syllabi should be framed block wise/unit wise; No of blocks and units may change)		
Block 1	Plant Biotechnology	
Unit I	Introduction to Biotechnology • A brief introduction to Biotechnology; Recombinant DNA technology: Restriction endonucleases, DNA Modifying enzymes, DNA polymerases; Vectors, Markers and reporter genes, Cloning, Screening of recombinant clone; Polymerase chain reaction: Principle, method, variants and practical applications; cDNA	
Unit II	Gene cloning and identification • Genomic and cDNA library, Hybridization techniques: Southern, northern and western hybridization; FISH; Molecular markers: RFLP, RAPD, AFLP, SSR, SNP; Functional genomics: Quantitative Real Time PCR, Microarray, RNA interference, Mutagenesis and Genome editing, Protein Production strategies in Expression System; Metagenomics	
Unit III	Methods of gene transfer • Agrobacterium mediated genetic transformation of plants, Regeneration methodologies and Screening of transformants; Genetic engineering and its applications in Agriculture: Genetic manipulation of pest resistance, abiotic and biotic stress tolerance, Molecular farming; Transformation of chloroplast genome and its advantage; Biosafety concerns in Plant Biotechnology	
Block-2	Biosafety and IPR	
Unit IV	Bio-safety and Risk Assessment • Bio-safety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety.	
Unit V	WTO and International Agreements Related to Biosafety; • WTO and other international agreements related to biosafety; Cross border movement of germplasm; Risk management issues containment. The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secret, patents, geographical indications, etc.	

Unit VI	VI Laboratory and Environmental Biosafety; General principles for the laboratory and environmental biosafety; healthy aspects; toxicology, allergenicity, antibiotic resistance etc. Impact on environment;
Unit VII	Gene flow in Natural and Artificial Ecologies Gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of super-weeds/super viruses etc.
Unit VIII	Ecological aspects and impact on biodiversity; Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-isotopic procedures; Benefits of transgenics to human health, society and the environment.
Unit IX	Convention on biological diversity; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products. Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing
Block-3	History of Botany
Unit X	History of Botany-I A brief introduction of major discoveries in Botany and contribution of renowned Indian scientists: Prof. Birbal Shani, Panchanan Maheshwari, Prof. Shiv Ram Kashyap, Prof. M.O.P. Iyengar, Prof. P.N. Mehra, Prof. Divya Darshan Pant, Prof. K.C. Mehta, Prof. R.N. Singh, T.V. Desikachary, Prof. Ramdeo Mishra and K.S. Bhargava
Unit XI	History of Botany-II A brief introduction of major discoveries in Botany and contribution of renowned scientists: Pier Antonio Micheli, Melvin Kelvin, Sir Hans A. Krebs, Erick Acharius, Kary Banks Mullis, Edwin Southern, E.J. Butler, Prof. F.E. Fritsch
Unit XII	History of Botany-III - A brief introduction of major discoveries in Botany and contribution of renowned scientists: Prof. T.H. Morgan, Toppur Seethapathy Sadasivan, - Lynn Margulis, Sir Charles Darwin, Sir George Bentham, Sir Joseph Dalton Hooker, Carolus Linnaeus
1. Brown, T.A., 1999, Genomes, John Wiley & Sons (Asia) Pvt. Ltd., Singapore 2. Chawla, H.S., Introduction to Plant Biotechnology (2nd edition), Oxford and IBH Publishing, Co. Pvt. Ltd., New Delhi. 3. Glick, B.R. and Pasternak, J.J., 1998, Molecular Biotechnology: Principles and Applications, ASM Press, Washington DC. 4. Gupta, P.K. 1996, Elements of Biotechnology, Rastogi & Co., Pub., New Pub., Meerut, India. 5. Henry, R.J. 1998. Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK.	
This course can be opted as an elective by the students of following subjects: NA	
Suggested equivalent online courses (MOOCs) for credit transfer: NA	

Course prerequisites: To study this course, a student must have qualified B.Sc with Botany		
Programme: M.Sc.	Year: II	Semester: IV
Subject: Botany		
Course Code: PGBY-123 N (D)	Course Title: Dissertation and Vica-voce	
Course Objectives: In the last semester of Masters the main objective of the exposure of students towards project/dissertation is to elevate their understanding into the practical and experimental aspects of some targeted areas of chemistry. This course will develop their analytical ability and will provide them an apt exposure to work in any research group and will motivate them to execute research in the area of their interest in chemical sciences.		
• Course Outcomes: • Students will be able to plan and strategize a scientific problem, and implement it within a reasonable time frame. • It is expected that after completing this project dissertation, students will learn to work independently and how to keep accurate/readable record of assigned project. • In addition, students will be able to know the library search and handle the data in a meaningful way. • Also, students will be able to interpret the spectral data independently. • Subsequently, the students should be able to critically examine research articles, and improve their scientific writing/communication skills and power point presentation.		
Credits: 04	Type of Course: Core (√) /Elective	
Max. Marks: 100	Min. Passing Marks: 36	
References: For project work and dissertation, the area of the work would be to be decided by the advisor/mentor. On completion of the project work, students have to submit the work in the form of a dissertation followed by oral presentation in the presence of faculty members.		

APPENDIX-II

Guidelines for preparing Research Project/Dissertation is available at link:

http://14.139.237.190/upload_pdf/01_02_2023_Guidelines_fo_Project_Lit_Survey_Dissertation.pdf