RAJIV GANDHI
GOVT. P. G. (AUTONOMOUS) COLLEGE
AMBIKAPUR (C.G)

CHOICE BASED CREDIT SYSTEM
(CBCS)

Syllabus

for

Master of Science

in

BOTANY

SEMESTER SYSTEM

PROGRAM OUTCOMES OF POSTGRADUATE DEGREE PROGRAMS

Students would be benefited with knowledge of core subjects like plant diversity, physiology and biochemistry, molecular cytogenetics and application of statistics etc. which are offered in these subjects Modules on analytical techniques, plant tissue culture and phytochemistry would make them obtain skills in doing research. All the courses in the programme are carefully designed to equip the students for competitive exams like CSIR NET, SET etc. and to write research proposals for grants.

PO1: Application of knowledge

Maintain a high level of scientific excellence in botanical research with specific emphasis on the role of plants. Create, select and apply appropriate techniques, resources and modern technology in multidisciplinary way. Practice of subject with knowledge to design experiments, analyze and interpret data to reach to an effective conclusion.

PO2:Ability to covey the concept clearly

They would identify, formulate and analyze the complex problems with reaching a substantiated conclusion. Logical thinking with application of biological, physical and chemical sciences. Learning that develops analytical and integrative problem-solving approaches.

PO3:Honesty and Integrity with Global Thinking

Student should be aware of ethical issues and regulatory considerations while addressing society needs for growth with honesty. Knowledgeable discipled students with good values, ethics, kind heart will help in nation building globally.

PO4:Environmental and Sustainability

Best problem-solving skills in students would encourage them to carry out innovative research projects thereby making them to use knowledge creation in depth. Understand the impact of the plant diversity in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO5: Scope and importance of Botany

Student will understand scope and importance of Botany in every field especially in dealing with societal and environmental issues, agriculture, ethics and healthcare.

PO6:Life Long learning and Problem solving

They would lend the support to other students to grow with them with equal opportunities. Student will also understand and solve problems of relevance to society to meet the specified needs using the knowledge, skills and attitudes acquired.

PO7: Practical skills and Modern tool usage

Students learn to carry out practical work, in the field and in the laboratory, with minimal risk. They gain introductory experience in different field of botany. This will also help to Create, select, and apply appropriate techniques, resources, and modern instruments and equipments for Biochemical estimation, Molecular Biology, Biotechnology, Plant Tissue culture experiments, cellular and physiological activities of plants with an understanding of the application and limitations.

PO8: Transferable and Technical skills

1. Use of IT (word-processing, use of internet, statistical packages and databases).
2. Communication of scientific ideas in writing and orally.
3. Ability to work as part of a team.
4. Ability to use library resources.
5. Time management.
6. Career planning.

- **M. Sc. in BOTANY** **FACULTY OF SCIENCE**
- **FIRST SEMESTER** (ODD SEMESTER)

Eligibility Criteria (Qualifying Exams)	Admission Criteria	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
						L	T	P	Thy	P
Bachelor Degree in any Science (Pure & Bioscience)	1) Merit List 2) Entrance Test (written or/and oral) if decided by the University 3) Observance of Reservation Policy.	PD3-701	CCC	**CELL AND MOLECULAR BIOLOGY**	6	4	2	0	3	0
		PD3-702	CCC	**ALGAE**	6	4	2	0	3	0
		PD3-701 & PD3-702	CCC	**LAB – A :- CELL AND MOLECULAR BIOLOGY & ALGAE (PRACTICAL)**	3	00	00	3	0	3
		PD3-703	CCC	**PHYSIOLOGY AND BIOCHEMISTRY**	6	4	2	0	3	0
		PD3-703 & PD3-706	CCC& ECC/CB	**LAB –B:- PHYSIOLOGY AND BIOCHEMISTRY & ENVIRONMENTAL SCIENCE (PRACTICAL)**	3	00	00	3	0	3
		PD3-704	PRJ/FST/EST	**SOCIAL OUTREACH AND SKILL DEVELOPMENT ¼MEDICINAL PLANT AND THEIR CULTIVATION½**	6	00	00	9	00	4
		PD3-705	ECC/CB	CONSTITUTIONALISM & INDIAN POLITICAL SYSTEM	6	4	3	00	3	00
		PD3-706	ECC/CB	**ENVIRONMENTAL SCIENCE**						
		MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL = 36					

Cell and Molecular Biology

(Course Code: –PD3-701)

Course outcome: - After successful completion of this course, students will be able to understand: -

1. Co1 – the cell structure in relation to function of cells the fundamental unit of life, are concerned in this course along with molecules present in cells.
2. Co2 - Understanding of the structure and function of cell wall plasma membrane and how the packaging of DNA. Students will also know the gene regulation process in prokaryotes.
3. Co3 – Students will understand about cell division and apoptosis and also understand the rotted various cell organelles.
4. Co4 – students will understand about fine structured Gene DNA replication and transcription in protein synthesis understanding the different structural and numerical changes why? And how?
5. Co5-Understand the instruments, techniques and good lab practices for working in a Molecular laboratory.
6. Co6-Develop skill to operate the instrument in laboratory.
7. Co7-Can be employed in the genetic laboratory & start his own venture.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1							√
PO2	√		√	√			
PO3							
PO4							
PO5						√	√
PO6							
PO7		√			√	√	
PO8							

M.Sc. (BOTANY)			**IST SEMESTER**
COURSE CODE: PD3-701	**PAPER-I**		**COURSE TYPE: CCC**
COURSE TITLE: CELL AND MOLECULAR BIOLOGY			
CREDIT:6 + 3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Introduction to modern tools and techniques of cell biology**: Gel electrophoresis (Agarose and PAGE), Blotting Technique (Southern, Northern and western blotting), DNA microarray. Cell fractionation.
18Hours	**Cell components and their functions**: Dynamic structure, functions and biogenesis of cell wall and plasma membrane; its components, **Chromosome:** Morphology and fine structure of chromosome and numerical changes in chromosome. Chromatin structure in eukaryotes;
18 Hours	**Cell multiplication and turnover**: Cell Cycle and cell cycle regulation; Cell division; Apoptosis; New insights in structure and function of cytoplasmic cell organelles (nucleus; golgi complex, endoplasmic reticulum, ribosomes, mitochondria, chloroplast).
18Hours	**Gene structure, regulation and expression in eukaryotes:** DNA replication; transcription and translation- (Structure, Mechanism and enzyme responsible) RNA splicing, condensation and packaging of DNA in prokaryotes and eukaryotes. Gene regulation in Eukaryotes and prokaryotes.

18Hours	**Organellar genomes**: Organization and function of mitochondrial and chloroplast genomes, diversity and evolution of organelle genomes, mitochondrial DNA and male sterility. Structure and function of plants cytoskeletal gene and gene products, protein sorting.
LABORATORY WORK (PD3-701)	1. To exemplify the use of phase contrast and fluorescence microscopy in plant biology by studying phase objects and auto fluorescent specimens or those stained with Fluoro chromes, such as, carbo fluoresce in diacetate, aniline blue, white, Evans blue and neutral red colour. 2. Isolation and purification of nuclei and their staining with Feulgen stain or DAPI. 3. Isolation of mitochondria and their visualization with Janus green B and mitotracker. 4. Isolation of chloroplasts and determination of number of chlorophyll molecules per chloroplast. 5. Comparing the effect of some physical and chemical factors on the efficiency of photosynthetic electron transport. 6. To study the effect of inhibitors and uncouplers on the activity of succinic dehydrogenase, a marker enzyme of mitochondria. 7. *In situ* visualization of microfilaments and microtubules by fluorescent labelling. 8. *In silico* analysis (sequence comparison) of mitochondrial and chloroplast genes for identification of the loci for interspecific discrimination. 9. Molecular characterization of GUS-actin constructs in *Arabidopsis thaliana* using microscopy and PCR. 10. Multiple sequence alignment and ontology based database searches on selected plant cytoskeletal genes to deciphering the molecular phylogeny of cytoskeleton genes. 11. Immuno staining of nuclei, chloroplast and/or mitochondria.
SUGGESTED READINGS	1. Alberts B, Johnson A, Lewis J, Raff Martin, Roberts K and Walter P. (2007) Molecular Biology of the Cell. Garland Publ., New York. 2. Bonifacino JS, Dasso M, Harford JB, Liipincott-Schwartz J and Yamada KM. (2004) Short Protocols in Cell Biology. John Wiley & Sons, New Jersey. 3. Bregman AA (1987) Laboratory Investigations in Cell Biology. John Wiley & Sons, NewYork. 4. Hawes C and Satiat-Jeunemaitre B (2001) Plant Cell Biology: Practical Approach. Oxford University Press, Oxford. 5. Hirt RP and Horner DS (2004) Organelles, Genomes and Eukaryote Phylogeny: An evolutionary synthesis in the age of genomics. CRC Press. 6. Karp G. (2008) Cell and Molecular Biology: Concepts and Experiments. John Wiley &Sons. 7. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and MatsudaireP (2008) Molecular Cell Biology. WH Freeman & Co., New York. 8. Ruzin SE (1999) Plant Microtechnique and Microscopy. Oxford Univ. Press, Oxford. 9. Wischnitzer S. (1989) Introduction to Electron Microscopy. Pergamon Press, New York.

Algae

(Course Code: –PD3-702)

Course Outcome: – After completion of this course the students will be able to –

Co1 – Understand and explain the thallus organization cell structure and reproduction in various group of algae.

Co2 – Understand the general characters, habitats range of thallus, structure, organization, reproduction economic importance of algae.

Co3 – Understand the process of algal culturing techniques in the laboratory.

Co4 – Understand the technique of cryopreservation aquaculture of micro and macro algae cultivation.

Co5 – Understand the use and application of seaweeds and agar and role of algae in bioengineering.

Co6-- Understand the techniques and good lab practices for working in a laboratory.

Co7- Develop skills for preparation of slides.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1		√	√		√		
PO2	√	√		√			
PO3							
PO4				√			
PO5							
PO6							
PO7			√		√		√
PO8	√		√		√	√	√

M.Sc. (BOTANY)			IST SEMESTER
COURSE CODE: PD3-702		**PAPER-II**	**COURSE TYPE: CCC**
COURSE TITLE: ALGAE			
CREDIT:6 +3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Diversity and distribution of the algae**: Classification, General characters, Habitats, systematic study of range of Thallus organization, cell structure and reproduction in algae. Pigmentation in algae; different types of life cycle in algae.
18Hours	**Classification:** General characters, habitats, range of thallus structure, organization, reproduction, Phylogeny and interrelationship of following groups of algae: - Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta,
18 Hours	**Classification:** General characters, habitats, range of thallus structure, organization, reproduction, Phylogeny and interrelationship of following groups of algae: Phaeophyta and Rhodophyta. Economic importance of algae; *Chlamydomonas* and *Porphyra* as modern experimental systems.
18Hours	**Algal Biotechnology**: Historical perspectives, algal culturing techniques in the laboratory, tissue and cell culture studies in seaweeds. Cryopreservation, aquaculture (micro and macro algae cultivation), **Algal biofuels** – algal biodiesel, bio-ethanol and biological hydrogen production; Algae in global warming – carbon capture by algae.
18Hours	**Industrial Phycology**: Products, processes and applications, seaweeds polysaccharides like Agar. Bioactive compounds from algae: Bio-fertilizers; Algae in bioengineering.

LABORATORY WORK (PD3-702)	1. Study of diversity of freshwater and marine algae. 2. Raising of pure culture. 3. Phytoremediation experiments 4. Microtechniques
SUGGESTED READINGS	1. Andersen RA (2005). Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA. 2. Cole KM and Sheath RG (1990). Biology of the Red Algae. Cambridge Univ. Press, Cambridge. 3. Fritsch FE (1945). The Structure and Reproduction of Algae. Vol. II. Cambridge Univ. Press. Cambridge, London. 4. Isabella A. Abbott, George J and Hollenberg (1993). Marine Algae of California. Stanford University Press. USA. 5. Lee RE (1989). Phycology. Vol. II. Cambridge Univ. Press. Cambridge, USA. 6. Sahoo D & Qasim SZ (Eds), (2002). "Sustainable Aquaculture". APH Publishing Corporation, New Delhi, India. 7. South GR and Whittick A. (1987). Introduction to Phycology. Blackwell Scientific Publications. London.

Physiology and biochemistry

(Course Code: –PD3-703)

Course Outcome: –

Co1 – After completion of this course student will understand how enzymes serve important function in body, indigestion and metabolism. They have developed knowledge about pathway of water through xylem and phloem.

Co2 – Student will understand the importance of photosynthesis in plants. They will also understand photosynthesis is one of the most important processes that allow plants to live.

Co3 – Student will come to know that energy produced by respiration is essential for normal functioning of body. They will also understand functional lipid and role of nitrogen cycle in environment.

Co4 – Student will be able to know the concept of different plant growth hormones and their role in plant growth and stress physiology.

Co5 – Student will be able to know the mechanism of flowering. They also understand the circadian rhythm and plant movements.

Co6 -Learn the symptoms of Mineral Deficiency in crops and their management.

Co7- Assimilate Knowledge about Biochemical constitution of plant diversity

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1		√	√			√	
PO2	√	√	√		√		√
PO3							
PO4							
PO5							
PO6		√		√			
PO7							√
PO8						√	

M.Sc. (BOTANY) SEMESTER			**IST**
COURSE CODE: PD3-703		**PAPER-III**	**COURSE TYPE: CCC**
COURSE TITLE: PHYSIOLOGY AND BIOCHEMISTRY			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Biomolecule and catalyst:** Amino Acid and proteins (structure, types and configuration) classification of protein, protein folding and protein sequencing; Structure, types and biological function of Carbohydrates Lipid and Vitamins. **Enzymes:** Enzymes and its kinetics, naming and classification of enzyme, Enzyme inhibition and Regulatory Enzyme. Isozyme, Ribozyme and Zymogen.
18Hours	**Plant-Water relations:** Concept of Diffusion, Osmosis, DPD and Water Potential**.** Absorption of water by land plants, Ascent of sap, Mechanism of ion Absorption, Translocation in plants- phloem loading and unloading. **Transpiration:** types, mechanism and principal of Transpiration, regulation of transpiration.
18 Hours	**Photochemistry and Photosynthesis:** General concepts of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photo-oxidation of water, carbon assimilation (C3, C4 and CAM cycle) Photorespiration and its significance, biosynthesis of starch and sucrose.
18Hours	**Respiration and lipid metabolism:** Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system. **Nitrogen metabolism**: Mechanism of Nitrogen metabolism, Nitrogen fixation by plants and environment.

18Hours	**Plant hormones and other growth regulators**: Concept, Synthesis, Signalling and function of Plant growth regulator i.e. Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid, classical approaches and use of mutants in understanding hormone actions. **Sensory Photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins. Floral induction (ABC model), Plant movements.
LABORATORY WORK (PD3-703)	1. In vivo assay for nitrate reductase in leaf tissues. 2. Comparative assessment of methods for protein quantitation. 3. Study of enzyme kinetics for determination of Km value, nature of inhibition – Competitive / non competitive. 4. Study of enzyme kinetics for effect of time/ enzyme concentration/ pH. 5. Extraction of proteins from plant tissue and their quantitative (Bradford's) and qualitative (SDS, PAGE gel) analysis. 6. Detection of phosphoproteins in plant (*Brassica*) extract by pro Q diamond staining. 7. Qualitative and quantitative analysis of photosynthetic pigments and anthocyanins by spectrophotometric and chromatographic techniques. 8. PAGE analysis of pigment-protein complexes from chloroplasts.
SUGGESTED READINGS	1. Ainsworth C (2006) Flowering and its Manipulation, Annual Plant Reviews, Vol. 20. Blackwell Publishing, Oxford, U.K. 2. Brown TA. (2002) Genomes, BIOS Scientific Publishers Ltd, Oxford, UK. 3. Buchanan B, Gruissem G and Jones R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA. 4. Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands. 5. Jordan BR. (2006) The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K. 6. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition, W.H. Freeman and Company, New York, USA. 7. Nelson DL and Cox MM. (2004) Lehninger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA. 8. Taiz L and Zeiger E. (2006) Plant Physiology, 4th Edition, Sinauer Associates Inc. Publishers, Massachusetts, USA.

Medicinal plants and their cultivation

(Course Code: –PD3-704)

Course Out Come – On Completion of this course the students will be able to-

Co1 – Understand the method of establishment of nursery of medicinal plants and gain the know led knowledge how the medicinal plants cultivate.

Co2 – Understand the method of preparing the various herbal product kike candy, toffee, murabba and herbal gulal.

Co3 – Understand the process of the production of various beauty product from aloevera leaves and bio-diesel from jetropha seeds.

Co4 – Understand the method to prepare the insecticide from neem seed, karanj seed and mustard seeds. They students will also know the production of essential oil.

Co5 – Students will get knowledge about the priministers employment generation programme and also know the function of national medicinal plant Board.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5
PO1	√	√	√		
PO2					
PO3					√
PO4					√
PO5		√	√	√	
PO6					
PO7	√			√	
PO8	√			√	

M.Sc. (BOTANY)			**IST SEMESTER**
COURSE CODE: (VAC) PD3-704		**PAPER-IV**	**COURSE TYPE: CCC**
VALUE ADDED COURSE			
COURSE TITLE: MEDICINAL PLANTS AND THEIR CULTIVATION)			
CREDIT:6		**HOURS: 90**	
THEORY:2	**PRACTICAL:4**	**THEORY:30**	**PRACTICAL:60**
DISTRIBUTION OF MARKS			
SEE MARKS **THEORY: 70**	**PRACTICAL:00**	**IA MARKS** **INTERNAL ASSESSMENT : 30**	

OBJECTIVE: THE BASICS OF MEDICINAL PLANTS AND THEIR CULTIVATION AND USES

6 Hours	Project Profile for the establishment of nursery of medicinal plants. Projects Profile for the commercial cultivation of medicinal plants. Project Profile for the establishment of herbal collection Centre. Project Profile for the production of herbal powder.
6 Hours	Project Profile for the production of Herbal Extract. Project Profile for the production of various fruit products like Candy, Toffee, Murabba, Supari from Alma Fruits etc. Project Profile for the production of Herbal Gulal.
6 Hours	Project Profile for the production of Aloe Vera juice and Gel from Aloe Vera leaves. Production of Aloe Vera powder. Production of Bio-diesel from Jetropha seeds.
6 Hours	Project Profile for the production of oil from Neem and Karanj seeds. Production of Bio-Insecticide from Mustard seeds, Production of essential oils, Establishing herbal mosquito repellent unit.
6 Hours	Project Profile for the production of glasses and cubes from Vijaysar or *Pterocarpus marsupium* for Diabetic patients. Production of Garlic powder, production of herbal Pesticides. Priminister's employment generation programme, National Medicinal Plants Board.

SUGGESED READINGS	1. Medicinal Plants Cultivation & Their Uses by H. Panda, 2002 2. Herbs Cultivation and Medicinal Uses by H. Panda 1999 3. A Handbook of Medicinal Plants: A Complete Source Book by Narayan Das Prajapati 1950 4. Midwest Medicinal Plants: Identify, Harvest, and Use 109 Wild Herbs for Health and Midwest Medicinal Plants by Lisa M Rose.2017 5. Gallery of medicinal plants (dravyaguna vigyan) by monika sharma 2022

Environmental Science

Course Code: –PD3-706

Course Outcome

Co1 – After completion of this course student will be able to know the environmental stresses and their management like global climatic change and global warming. They also will understand the effect of air, water and soil pollution in environment.

Co2 – Student will understand the uses of fertilizer, pesticides and other chemical in agriculture and their impact on biodiversity of microbe, animals and plants. They will also get knowledge about environmental issues, policies and regulation.

Co3 – Student will understand the regulative organization in community. Student will get to know about how changes take place during ecological succession.

Co4 – Student will develop knowledge about structure and function of ecosystem. They also will understand how to conservation takes place of agriculture forest and soil.

Co5 – Student will develop knowledge about human health and environmental change. They also will understand the importance of natural resources and their management and application of GIS.

Co6- They will also understand the role of environment on human heath henceforth develop emotional attachment for sustainable development

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6
PO1	√		√			
PO2		√				√
PO3						
PO4	√		√	√	√	
PO5						√
PO6					√	
PO7						
PO8				√		

M.Sc. (BOTANY) SEMESTER			**IST**
COURSE CODE: PD3-706 ECC		**PAPER-V**	**COURSE TYPE:**
COURSE TITLE: ENVIRONMENTAL SCIENCE			
CREDIT: 6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	Environmental Stresses and their management, global climatic pattern and variations over time, global climatic changes and global warming, atmospheric ozone, acid and nitrogen deposition. Environmental pollutants- air, water and soil pollution.
18Hours	Use of fertilizer, pesticides and other chemicals in agriculture and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants. Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals, environmental issues, policies and regulations.
18 Hours	**Vegetation development:** Mechanism of ecological succession, (facilitation, tolerance and inhibition models), changes in ecosystems properties and regulations during succession.
18Hours	**Origin of intra-population variation:** Population and the environment, ecades and ecotypes, Ecosystems and living organism. Conservation and management agriculture, forest and soil.
18Hours	Major ecosystem of the world and India. Human health and environmental change, population issues, natural resources and their management. Applications of GIS.

LABORATORY WORK (PD3-706)	1. E. coli growth curve. 2. Preparation of competent cells and transformation of E. coli (chemical/electroporation method). 3. Plasmid DNA isolation, quantification and agarose gel electrophoresis. 4. Restriction digestion, elution and cloning in E. coli. 5. RCR. 6. Preparation of protein extracts from E. coli, quantification and SDS-PAGE analysis. 7. Inducible expression of proteins in E. coli. 8. ELISA. 9. Southern Hybridization. 10. Yeast transformation. 11. RNA extraction and preparation of cDNA.
SUGGESED READINGS	1. Buchanan B, Gruissem G and jones R(2000). Biochemistry and Molecular Biology of plants, American society of plant physiologists, USA. 2. Harlow and Lane D (eds.) (1988). Antibodies – A laboratory Manual; cold spring Harbor laboratory, USA. 3. Lieber DC (2006). Introduction to Proteomics: Tools for new biology; Humana Press, NJ. 4. Pennington SR, Dunn M J (Eds.) (2002). Proteomics: From Protein Sequence to function, BIOS scientific publishers, United Kingdom. 5. Sambrook J and Russell DW (2001). Molecular cloning – A Laboratory manual, Vols I-III, cold Spring Harbor laboratory, USA. 6. Singer M and Berg P (1991). Genes and Genomes: A changing perspective; University Science Books, CA, USA.

- **M. Sc. in BOTANY** **FACULTY OF SCIENCE**
- **SECOND SEMESTER** (EVEN SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the First semester examination irrespective of any number of back/ arrear papers	PD3-801	CCC	**GENETICS**	6	4	2	00	3	00
	PD3-802	CCC	**ADVANCES IN ARCHEGONIATAE (BRYOPHYTA AND PTERIDOPHYTA)**	6	4	2	00	3	0
	PD3-801&PD3-802	CCC	**LAB – A :- GENETICS& ADVANCES IN ARCHEGONIATAE (BRYOPHYTA AND PTERIDOPHYTA) (PRACTICAL)**	3	00	00	3	00	3
	PD3-803	CCC	**GYMNOSPERM**	6	4	2	00	3	0
	PD3-803&PD3-806	CCC ECC/CB	**LAB – B :- GYMNOSPERM & FUNGI (PRACTICAL)**	3	00	00	3	00	3
	PD3-804	OSC	**RESEARCH METHODOLOGY & COMPUTER APPLICATION: BASICS**	6	4	3	00	3	00
	PD3-805	ECC/CB	ENVIRONMENTAL AND FOREST LAWS	6	4	3	00	3	00
	PD3-806	ECC/CB	**FUNGI**						
	MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL= 36					

Genetics

Course Code: - PD3-801

Course outcome: –

Co1 – Student will understand about fine structure of gene and viral and bacterial genomes students will also understand the Mendel law of inheritance and organelle inheritance.

Co2 – Student will understand the mechanism of linkage and crossing over and they also know the interaction of gene, genetic recombination producing the characters differently.

Co3 – Understand the role and process of mutation and different mutagenic agent which brings about mutation in the organism. Student will also know about on co genes and cancer.

Co4 – Student will understand the different aspect of genetics. They also understand how to DNA damage and repair themselves.

Co5- Understand the techniques and lab practices for working in field of Anatomy.

Co6- Can be employed in genetical laboratory &start his own venture.

Co7- Develop understanding of gene interaction and pedigree analysis.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	√		√				√
PO2	√	√		√			√
PO3							
PO4							
PO5						√	
PO6		√					
PO7					√		
PO8					√		

COURSE CODE: PD3-801PAPER - I COURSE TYPE: CCC			
COURSE TITLE: GENETICS			
CREDIT:6+3		HOURS:90+45	
THEORY: 6	PRACTICAL:3	THEORY:90	PRACTICAL: 45
MARKS			
THEORY: 100 (70+30)		PRACTICAL:100/2	

Scheme of Marks:

iv. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

v. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

vi. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Microbial Genetics:** Viral and bacterial genomes and derived vectors; Recombination inviruses and bacteria (transformation, conjugation and transduction); Fine structure of gene;Prokaryotic gene regulation, Parasexual cycle. **Mendelian and Non-Mendelian Inheritance:**Chromosome theory of inheritance;Mendelian laws; Gene interactions; Organelle inheritance.
18Hours	**Eukaryotic Genome:** Gene structure, Gene regulation. **Recombination in Eukaryote**s**:** Linkage and crossing over: basic concepts, linkage maps,correlation of genetic and physical maps, molecular markers and construction of linkage maps;Molecular mechanism of recombination.
18 Hours	**Mutation:** Basic concept, spontaneous and induced mutations, allele theory, physical andchemical mutagens; Molecular basis of mutations; Transposons and their use in mutagenesisand gene tagging in plant systems; Oncogenes and cancer.
18Hours	**Concepts in**: Developmental genetics; Behavioral genetics; Population genetics andQuantitative genetics. DNA damage and repair mechanisms, inherited human diseases and defects in DNA repair.
18Hours	**Cytogenetics**: Sexdetermination: mechanisms, sex chromosomes; Chromosomal aberration:Duplications,deficiencies/deletions, inversions interchanges/translocations; Role of chromosomalaberrations in crop evolution; Ploidy changes: Haploids, polyploids and aneuploids; Genomeanalysis in crop plants.

LABORATORY WORK(PD3-801)	1. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division(*Phlox, Allium* and *Rhoeo*). 2. Extraction of genomic DNA from plants by CTAB method. 3. Analysis of molecular polymorphism in parental lines and derived mapping populationusing different types of molecular markers. 4. Construction of a linkage map using available data. 5. Mutagenesis experiments in *E. coli.* 6. Experiments in *Neurospora*/ *Drosophila* genetics.
SUGGESTED READINGS	1. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd.USA. 2. Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Sons. 3. Hartl DL and Jones EW (2007). Genetics – Analysis of Genes and Genomes, 7th edition,Jones and Barlett publishers. 4. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). Genetics – From Genes to Genomes, 3rd edition, McGraw Hill. 5. Lewin B (2008). Genes IX, Jones and Barlett Publishers. 6. Singh RJ (2002). Plant Cytogenetics, 2nd edition, CRC Press. 7. Smartt J and Simmonds NW (1995). Evolution of Crop Plants (2nd Edition) Longman. 8. Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall). 9. Weising K, Nybom H, Wolff K and Kahl G (2005) DNA Fingerprinting in Plants: Principles, Methods and Applications, 2nd ed. Taylor and Francis Group, Boca Raton, FL.

Advance in Archegoniate (Bryophyta and pteridophyta)

Course Code: - PD3-802

Course Outcome: –After completion of this course students will gain knowledge of -

Co1 – The characters, distribution, classification and regeneration in Bryophytes and pteridophytes.

Co2 – General characters, classification and reproduction of different ovule mosses, sphagnales and polytrichales.

Co3 – The classification of pteridophytic classes and the morphological and anatomical characters of genus included in the different pteridophytic order.

Co4 - Economic Importance of Bryophyte and gain knowledge about fossil pteridophytes.

Co5- Students will also know how the stele evolution occurs in pteridophytes and also familiar with the work done by Indian pteridologist.

Co6- They will understand the techniques and good lab practices for working in a laboratory and develop skills for preparation of slides.

Co7- Can prepare herbaria of bryophytes and pteridophytes for business purpose.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1				√	√		
PO2	√	√	√				
PO3							
PO4							√
PO5				√			√
PO6					√		
PO7						√	
PO8						√	

M.Sc. (BOTANY)		IINDSEMESTER	
COURSE CODE: PD3-802		**PAPER - II**	**COURSE TYPE: CCC**
COURSE TITLE: ADVANCES IN ARCHEGONIATAE (BRYOPHYTA AND PTERIDOPHYTA)			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Bryophytes:** General characters, structure, distribution, reproduction, classification and life history of following groups of Bryophytes Marchantiales,Jungermanniales, Anthocerotales.
18Hours	General account, classificationand life cycle of mosses- sphagnales; sphagnum, andreaeales – andreaea, funariales: funaria, polytrichales: Polytrichum.
18 Hours	**Pteridophytes:** General character, reproduction, classificationand life cycleof following groups of Pteridophytes psilotales- psilotum, Isoetales- Isoetes, Ophiogolossales- Ophiogolossum, Protoleptosporangiopsida - Osmunda, Gleichenia,
18Hours	General character, reproduction, classification and life cycle of Dryopteris, Pteris, Marsileales, salviniales, Azollaceae. Morphological diversity and evolution of vegetative organs in Pteridophytes. Model system in Osmunda, Marsilea.
18Hours	Economic and ecological importance of bryophytes. Fossil pteridophytes, evolution of stele, heterospory and origin of seed habit in pteridophyta. Apogamy and apospory, coal formation.

LABORATORY WORK(PD3-802)	1. Study of structural modification in marchantiales, Jungermanniales, Isobryales and Hypnobryales. 2. Regeneration experiments, Effect of light, sugars and pH on regeneration. 3. Growth forms, water-holding capacity. 4. Effect of bryophyte extract on the growth of microbes. 5. Pollution Monitoring. 6. Systematics in bryophytes and Pteridophytes. 7. Cytological studies on bryophyte and ferns. 8. Evolution of reproductive pathways in Gymnosperms. 9. Spore viability test, Male and female cone and pollen study in gymnosperms.
SUGGESTED READINGS	1. Shaw AJ and B Goffinet(2000) Bryophytes Biology. Cambridge University Press. 2. Geissler and Greene SW(1982)Bryophyte Taxonomy, methods, practices and floristic exploration. J Cramer, Germany. 3. Dyes AF (Ed) (1979).The experiment Biology of ferns. Academic London. 4. Richardson DHS (1981) The Biology of mosses. John Wiley & Sons, Inc New York. 5. Bhatnagar SP and Moitra A (1996) Gymnosperms. New Age International (P) Limited, Publishers, New Delhi. 6. Singh Hardev (1978) Embryology of Gymnosperms. Encyclopedia of Plant Anatomy. Vol. X Gebruder Borntraegrl, Berlin, Stuttgart.

Gymnosperm

(Course Code: - PD3-803)

Course Outcome: – After completion of this course: -

Co1 – Student can gain the knowledge of evolution of gymnosperms and know about used less and fruit less seed plants.

Co2 – Student can gain the knowledge of the characters, distribution and classification of gymnosperms.

Co3 –Will understand the meaning of fossil and its use in the determination of age of plant material, understanding the applied knowledge and different aspect of paleo botany.

Co4 – Students can critically differentiate fossil and living fossil. Students will also understand the evolutionary tendencies and comparative morphology of cycadeoidales and cordaitales. Students can critically differentiate the character of different order of Gymnosperms.

Co5 – Student can gain knowledge of seed technology of conifers, somatic embryogenesis and litter decomposition.

Co6- Student can understand the techniques and lab practices for working in field and can initiate his laboratory of slide preparation and can sell the slide to the market

Co7-Develop skill for preparation of Plant Gymnosperm Herbarium.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	√			√			
PO2	√	√			√		
PO3							√
PO4			√				
PO5							√
PO6							
PO7			√			√	
PO8						√	

M.Sc. (BOTANY)		IINDSEMESTER	
COURSE CODE: PD3-803PAPER - III COURSE TYPE: CCC			
COURSE TITLE: GYMNOSPERM			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Introduction:** Gymnosperms, the vessel-less and fruitless seed plants varying in the structure of their sperms, pollen grains, pollen germination and the complexity of their female gametophytes, evolution of gymnosperms.
18Hours	**Classification of Gymnosperms and their distribution in India:** History of classification and Classification of Coulter and chamberlain(1917), Chamberlain(1934), D.D. Pant (1957), Taylor (1980)
18 Hours	**Brief account of the families of pteridospermales:** (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae). **General account of Cycadeoidales and Cordaitales.**
18Hours	Structure, reproduction anatomy and lifecycle in cycadales, ginkgoales, coniferales, Ephedrales, welwistschiales and gnetales (With the help of suitable example).
18Hours	Propagation of conifers using plant tissue culture approaches, advances in synthetic seeds technology of conifers, somatic embryogenesis and plantlet regeneration. Litter decomposition rate.

LABORATORY WORK(PD3-803)	1. Study of structural modification in marchantiales, Jungermanniales, Isobryales and Hypnobryales. 2. Regeneration experiments, Effect of light, sugars and pH on regeneration. 3. Growth forms, water-holding capacity. 4. Effect of bryophyte extract on the growth of microbes. 5. Pollution Monitoring. 6. Systematics in bryophytes and Pteridophytes. 7. Cytological studies on bryophyte and ferns. 8. Evolution of reproductive pathways in Gymnosperms. 9. Spore viability test, Male and female cone and pollen study in gymnosperms.
SUGGESTED READINGS	1. Shaw AJ and B Goffinet (2000) Bryophytes Biology. Cambridge University Press. 2. Geissler and Greene SW (1982) Bryophyte Taxonomy, methods, practices and floristic exploration. J Cramer, Germany. 3. Dyes AF (Ed) (1979). The experiment Biology of ferns. Academic London. 4. Richardson DHS (1981) The Biology of mosses. John Wiley & Sons, Inc New York.

Research methodology and computer Application Basics

(Course Code: - PD3-804)

Course Outcome: – This course is an optional but compulsory for completion of the degree. The student can co-relate the knowledge gained in this subject with his principled subject.

Co1 – After completion of this course students will be able to gain the basic knowledge of research and also know how to prepare a research proposal and selection of problem.

Co2 – Student will be able to know about the different tools of research and also gain the knowledge of different sampling technique.

Co3 – student will be able to gain the knowledge of different method of research which is important for completion of research.

Co4 – Student will be able to understand the measurements of data and interpretation of results and they also know how to research report writing.

Co5 – Student will be able to understand the fundamental of computer system they know about the different parts of computer system like hardware and software they also gain the knowledge of ms windows and control panel of operating system of computer.

Co6- Student will be able to understand the team attitude and will learn time management.

C07- Student will be able to start a venture of computer system

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1			√				
PO2	√			√	√		
PO3						√	
PO4							
PO5							√
PO6	√						
PO7		√		√	√		
PO8		√				√	

COURSE CODE: PD3-804PAPER-IV COURSE TYPE: OSC			
COURSE TITLE: RESEARCH METHODOLOGY & COMPUTER APPLICATION: BASICS			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL:00**	**THEORY:90**	**PRACTICAL: 00**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:00**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Concept of research:** Meaning and characteristics of research, steps in research process, Types of research - (i) Basic, applied and action research (ii) Quantitative and qualitative research, Areas of research in concern discipline. **Selection of problem for research:** Sources of the selection of the problem, Criteria of the selection of the problem, Drafting a research proposal, Meaning and types of variables, Meaning and types of hypotheses.
18Hours	**Tools of research:**Meaning and general information about construction procedure of (i) Questionnaire, (ii) Interview, (iii) Psychological test, (iv) observation (v) Rating scale (vi) Attitude scale and (vii) check list, Advantages and disadvantages of above tools. **Sampling:**Meaning of population and sample, Importance and characteristics of sample, Sampling techniques - i) Probability sampling: random sampling, stratified random sampling, systematic sampling, cluster sampling. ii) Non-probability sampling: incidental sampling, purposive sampling, quota sampling.
18 Hours	**Method of research:** Meaning and conducting procedure of following methods of research : Historical method, Survey method , Case study , Causal comparative method , Developmental methods, Experimental methods

18Hours	**Treatment of data:** Level of measurements of data, steps in treatment of data: editing, coding, classification, tabulation, analysis and interpretation of results. **Writing research report:** Sections of report: Preliminary section, Content section: various chapters, Supplementary section: appendices, references, abstract, Format and style.
18Hours	**Computer Fundamentals Computer System:** Features, Basic Applications of Computer, Generations of computers. **Parts of Computer System:** Block Diagram of Computer System; Central Processing Unit (CPU); Concepts and types of Hardware and Software, Input Devices - Mouse, Keyboard, Scanner, Bar Code Reader, track ball; Output Devices - Monitor, Printer, Plotter, Speaker; Computer Memory - primary and secondary memory, magnetic and optical storage devices. **Operating Systems - MS Windows:** Basics of Windows OS; Components of Windows - icons, taskbar, activating windows, using desktop, title bar, running applications, exploring computer, managing files and folders, copying and moving files and folders; **Control panel:** display properties, adding and removing software and hardware, setting date and time, screensaver and appearance; **Windows Accessories:** Calculator, Notepad, WordPad, Paint Brush, Command Prompt, Windows Explorer.
LABORATORY WORK(PD3-804)	**Office Software Package Word Processing - MS Word:**Creating, Saving, Opening, Editing, Formatting, Page Setup and printing Documents; Using tables, pictures, and charts in Documents; Using Mail Merge sending a document to a group of people and creating form, letters and label. **Spreadsheet - MS Excel:**Opening a Blank or New Workbook, entering data/Function/ Formula into worksheet cell, Saving, Editing, Formatting, Page Setup and printing Workbooks. **Presentation Software - MS Power Point:** Creating and enhancing a presentation, modifying a presentation, working with visual elements, adding Animations & Transitions and delivering a presentation.

SUGGESED READINGS	Agrawal, Y. P. (1988). **Better sampling: Concepts, Techniques and Evaluation.** New Delhi: sterling Publishers Private Ltd. Best, J. W. (1993). **Research in Education** (6th ed.) New Delhi: Prentice-Hall of India Pvt. Ltd. Broota, K. D. (1992) **Experimental design in Behavioral Research** (2nd ed.) New Delhi: Wiley Eastern Limited. Dasgupta, A. K. (1968). **Methodology of Economic Research**. Bombay: Asia Publishing House. Edwards, A. L. (1957). **Techniques of Attitude Scale construction.** New York: Appleton-Contury Gall, M. D., Gall, J. P. and Borg, W. R. (2007). **Educational Research: An introduction** (8th ed.) Coston: Allyn and Bacon. Garrett, H. E. & Woodworth, R. S. (1969). **Statistics in Psychology and Education**. Bombay: Vakils, Fecffer & Simons Pvt. Ltd. Goode, W. J. & Hatt, Paul K. (1952). **Methods in Social Research.** New York: McGraw-Hill. Gopal, M. H. (1964). **An Introduction to research Procedure in Social Sciences.** Bombay: Asia Publishing House. Hillway, T. (1964) **Introduction to Research (2nd ed.)** Noston : Houghton Miffin. Hyman, H. H., et al. (1975**). Interviewing in Social Research.** Chicago: University of Chicago Press. Kerlinger, F. N. (1983) **Foundation of Behavioural Research. (2nd Indian Reprint)** New York: Holt, Rinehart and Winston. Kothari, C. R. (2007) **Research Methodology: Methods & Techniques** (3rd ed.) New Delhi: Wishwa Prakashan.Fundamentals of Computers, Dr. P. Mohan, Himalaya Publishing House. Microsoft First Look Office 2010, K. Murray, Microsoft Press. Fundamental Of Research Methodology And Statistics, Y.K. Singh, New Age International (P) Limited, Publishers.Practical Research Methods, Dr Catherine Dawson, The Essence Of Research Methodology, Jan Jonker & Bartjan Pennink, Springer.

Fungi

(Course Code: - PD3-806)

Course Out Come: –After completion of this course-

Co1 – Students will beable to understand the structure nutrition and reproduction of Bacteria, virus, cyanobacteria and phytoplasma and identity them.

Co2 – Student will gain understanding of classification. Structure and reproduction of fungal species from different classes of fungi.

Co3 – Student will gain understanding of classification nutrition, structure and reproduction of different sub classes of class ascomycetes.

Co4 – Student will gain knowledge of imperfect fungi and the member of Basidiomycetes.

Co5- Student will understand the techniques and good lab practices for working in a laboratory and can develop Skill in Slide Preparation.

Co6- Student will develop skills for identifying fungal genera and using them for industrial purposes along with learns to identify fungal disease on the basis of symptoms.

Co7- Can initiate his own fungal culture laboratory and can start own enterprise on fungal products.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1							
PO2	√	√		√			
PO3							
PO4			√				
PO5						√	√
PO6							
PO7					√	√	
PO8					√		

M.Sc (BOTANY)		IINDSEMESTER	
COURSE CODE: PD3-806PAPER - V COURSE TYPE:ECC			
COURSE TITLE: FUNGI			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

I. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

II. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

III. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Microbiology:** General account, ultra-structure, nutrition and reproduction, biology and economic importance of Bacteria, Cyanobacteria, Viruses and phyto-plasma.
18Hours	**Mycology:** General characters and reproduction of fungi, classification, nutrition and economic importance of fungi. **General account of following groups of fungi:** Class myxomycetes, chytridiomycetes, Omycetes, zygomycetes.
18 Hours	**General account of class ascomycetes:** Sub- class hemiascomycetidae, sub-class Euacomycetidae, series plectomycetes, pyrenomycetes, discomycetes.
18Hours	**General account of class:** Deuteromycetes class Basidiomycetes, sub-class- Heterobasidiomycetidae, Homobasidiomycetidae.
18Hours	**The Lichens:** Introduction, Types, Structure, Reproduction and Economic Importance

LABORATORY WORK (PD3-806)	*1.* Slide Preparation: Identication and study of external and internal structure of fungi. *Phytophthora, Mucor, Rhizopus,* *2. Saccharomyces, Aspergillus,* *3. AgaricusPezziza, Puccinia;* *4. Alternaria. Cercospora,* *5. Preparation of the project on diseased leaf with their symptoms* *6.* Isolation and identification of pathogen from fungal diseased leaf.

SUGGESTED READINGS	1. Acquaah G (2007). Principles of plant Genetics and Breeding, Blackwell Publishing Ltd. USA. 2. Allard RW (1999). Principles of plant breeding (2nd Edition), john Wiley and Sons, ISBN 0471023094, 9780471023098. 3. Hartl and Jones (2007). Genetics-Analysis of Genes and Genomes, 7th edition, Johns and Barlett publishers. 4. Hartwell, Hood, Goldberg, Reynolds, Silver, Veris (2006). Genetics-From Genes to Genomes, 3rd edition, McGraw Hill. 5. Lewin B (2008). Genes IX, Jones and Barlett Publishers, ISBN-10: 0763740632. 6. Ram J. Singh (2002). Plant Cytogenetics, 2nd edition, CRC Press. 7. Simmonds (1995). Evolution of Crop Plants (2nd edition) Longman. 8. Strickberger (2008). Genetics, 3rd edition, Pearson (Prentice Hall).

- **M. Sc. In BOTANY** **FACULTY OF SCIENCE**
- **THIRD SEMESTER** (ODD SEMESTER)

Eligibility Criteria (Qualifying Exams)	**Course Code**	**Course Type**	**Course (Paper/Subjects)**	**Credits**	**Contact Hours Per Week**			**EoSE Duration (Hrs.)**	
					L	**T**	**P**	**Thy**	**P**
After appearing in the Second semester examination irrespective of any number of back/ arrear papers	PD3-901	CCC	**DEVELOPMENTAL BIOLOGY**	6	4	2	00	3	00
	PD3-902	CCC	**SYSTEMATICS, EVOLUTION AND TAXONOMY**	6	4	2	00	3	00
	PD3-901&PD3-902	CCC	**LAB – C :- DEVELOPMENTAL BIOLOGY & SYSTEMATICS, EVOLUTION AND TAXONOMY (PRACTICAL)**	3	00	00	3	00	3
	PD3-903	CCC	**PRINCIPLES OF ECOLOGY**	6	4	2	00	3	00
	PD3-903&PD3-905	CCC & ECC/CB	**LAB – D :- PRINCIPLES OF ECOLOGY & PATHOGENS AND PESTS OF CROP PLANTS (PRACTICAL)**	3	00	00	3	00	3
	PD3-904	OSC	**INTELLECTUAL PROPERTY RIGHTS**	6	4	3	00	3	00
	PD3-905	ECC/CB	**PATHOGENS AND PESTS OF CROP PLANTS**	6	4	3	00	3	00
	PD3-906	ECC/CB	TRIBAL STUDIES						
	PD3-907	ECC/CB	BIOINFORMATICS, COMPUTATIONAL BIOLOGY AND BIOSTATISTICS						
	PD3-908	ECC/CB	GENOMICS AND PROTEOMICS						
	PD3-909	ECC/CB	IMMUNOLOGY						
	MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 30			TOTAL= 36					

Developmental Biology

(Course Code:- PD3-901)

Course Out Come: – After completion of this course-

Co1 – Student will be able to know about plant anatomical structure, their development. They will also understand how growth of root and shoot apical meristem takes place.

Co2 – Structure will get knowledge about the various arrangement of leaf in plants. They will have developed knowledge about vascular tissues and its constituents by section and maceration, wood anatomy T.S., TLS, RLS. They also know about secretary tissues, laticifers, stomata and trichomes.

Co3 – Student will understand the floral architecture and how flowering takes place. They will also know about seed and fruit anatomy and evolution of seed.

Co4 – Student will able to know about mechanical tissue (collenchymas, sclerenchyma) and also understand the normal and anomalous secondary growth.

Co5 – Student will able to know about the mechanism of dormancy and overcoming the dormancy and also understand the mechanism of program cell death.

Co6-Student will able to understand the techniques and lab practices for working in field of Anatomy.

Co7- Student will able to Develop skills for preparation of Slides and can initiate his laboratory of slide preparation

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1		√	√				
PO2	√		√	√	√		
PO3							
PO4							
PO5							√
PO6	√						
PO7		√				√	
PO8						√	

M.Sc.(BOTANY)		IIIRD SEMESTER	
COURSE CODE: PD3-901PAPER - I		**COURSE TYPE: CCC**	
COURSE TITLE: DEVELOPMENTAL BIOLOGY			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

vii. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

viii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

ix. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Vascular plants:** Plant body and its development, The tissue**,** Meristem, RAM, SAM; patterns of cell fate, determination and lineage in root and shoot, The tissue system (differentiation of epidermis with special reference to stomata, trichrome and mesophyll). secretory ducts and laticifers tissue
18Hours	**Leaf growth and differentiation:** Theories of structural development and differentiation, development of leaf, and branches. Anatomy of dicotyledonsand monocotyledons leaf, anatomy of Gymnosperms leaf, anatomy of petiole, Anatomy of the phyllode. **Root and Shoot**: Internal organization of Root and stem, secondary growth; wood development and its diversity; cambial variants. Root –stem transition.
18 Hours	**Development of flower:** Origin of Reproductive shoot apex,Transition to flowering (vegetative to reproductive evocation), floral homeotic mutations in Arabidopsis and Antirrhinum plants, axis development in flower; flower; patterns of evolution in seed. Anatomical adaptation for special habitats(Xerophytes and Hydrophytes)
18Hours	**Anatomy in Relation to Taxonomy**: Hairs, stomata, Epidermal cell and Hypoderm, Veins petiole, cork endodermis, sclerenchyma of pericycle, width of medulary rays, bicolleteral bundle, cortical and medullary bundles Anamolous secondary thickening.

18Hours	**Latent life-dormancy:** Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy. **Senescence and programmed cell death (PCD):** Basic concepts of senescence and metabolic changes associated with senescence, influence of hormones and environmental factors on senescence. Types of cell death, PCD in the life cycle of plants
LABORATORY WORK(PD3-901)	1. Study of morphology and anatomy of thalloid and leafy forms of Bryophytes; Study of protonema. 2. Study of fern gametophyte and soral variations. 3. Comparative anatomy of conifers and gnetales. 4. Study of apical meristems with the help of dissections, whole mount preparations, sections and permanent slides. 5. Origin and development of epidermal structures (trichomes, glands and lenticels). 6. Study of xylem and phloem elements using maceration, staining, light and electron micrographs (xerophytes, hydrophytes and halophytes). 7. Study of secretory structures (nectarines and laticifers). 8. Study of secretory structures (normal and unusual) of selected woods with the help of wood microtome and permanent slides. 9. Study of the stages of pollen and ovule development in the wild and mutant plants using permanent slides, electron micrograph and available phenotypes. 10. Pollen in vitro germination methods: Sitting drop culture, suspendion culture, surface culture. 11. Correlation between fertility (stainability), viavility (TTC and FDA staining) and germinability (in vitro) of pollen grains. 12. Assessment of stigma receptivity by localizing peroxidases, non-specific esterases and phosphatases. 13. Aniline blue fluorescence method to localize pollen tubes to study different aspects of pollen-pistil interaction. 14. Use of DNA fluorochromes to localize nuclei during pollen and ovule development. 15. Study of post-fertilization stage with the help of permanent slides and electron micrographs. 16. Dissection of embryo and endosperm.

SUGGESTED READINGS	1. Anderson RA (2005) Algal culturing techniques. Physiological society of America. Elsevier academic press, USA. 2. Bhatnagar SP and Moitra A (2005) Gymnosperms. New age interactive (P) Ltd. Publishers, New Delhi. 3. Carlquist S (2001) Comparative wood anatomy, springer-verlag, germany. 4. Cutler DF (1978). Applied plant anatomy, Longman, United Kingdom. 5. Cutler EG (1978). Plant anatomy, part I&II, Edward Arnold, United Kingdom. 6. Dickinson WC (2000). Integrative plant anatomy, Harcourt academic press, USA. 7. Fahn A (1974) Plant anatomy, pergmon press, USA&UK. 8. Fosket DE (1994) Plant, growth and Development: A molecular Approach, Academic Press. 9. Fritsch FE (1935, 1945). The structure and Reproduction of algae vols. I and II. Cambridge University press, cambridge, UK. 10. Hopkins WG (2006). The green world: Plant development, Chelsea house publication. 11. Howell SH (1998) Molecular genetics of plant development, Cambridge university press. 12. Leyser O and Day S (2003) Mechanism of plant development, Blackwell press. 13. Mauseth JD (1988). Plant anatomy, the Benjamin/cummings publisher, USA. 14. Nair MNB (1998). Wood anatomy and Major uses of wood, faculty of forestry, university of putra Malaysia, Malaysia. 15. Parihar NS (1993) An introduction to embryophytavol I-bryophyta, volI-pteridophyta, central book dept. Allahabad. 16. Raghavan V (2000) developmental biology of flowering plants, springer, Netherlands. 17. Raghavan V (1997) Molecular embryology of flowering plants. Cambridge. University press. 18. Richards AJ (1986) Plant breeding system, George allen and Unwin. 19. Shivanna KR (2003) pollen biology and biotechnology, science publishers.

Systematics Evolution and Taxonomy

(Course Code: - PD3-902)

Course Out Come: – After completion of this course-

Co1 – Students will be able to know the probable ancestors of angiosperms, extinct species and also they will also understand adaptive features and technicality of international code of Botanical nomenclature.

Co2 – Student will be able to understand the various characters of plants are used as taxonomic evidence for the classification.

Co3 – Student will be able to understand how to prepare herbarium sheet and how to read floras. They will also get knowledge about monocotyledous family members.

Co4 – Student will be able to understand the differences between unisexuales and bisexuales members of dicotyledons.

Co5 – Student will able to understand the major system of classification with their merits and demerits.

Co6- Student will able to Understand the techniques and lab practices for working in field along with develop skills for preparation of Herbarium and can make own herbaria of that region.

Co7- They can initiate his laboratory of slide preparation and can sell the slide to the market.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	√					√	
PO2	√	√	√	√			
PO3							
PO4						√	
PO5							√
PO6					√		
PO7						√	
PO8			√				

M.Sc. (BOTANY) SEMESTER			**IIIRD**
COURSE CODE: PD3-902 TYPE:CCC		**PAPER - II**	**COURSE**
COURSE TITLE: SYSTEMATICS, EVOLUTION AND TAXONOMY			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word).

18 Hours	**Systematics and Evolutionary Biology:** History of developments in taxonomy: Systematics-concepts and component; Salient features of the international code of botanical nomenclature; Species and speciation. Classification system of taxonomy(Artificial, Natural and Phylogenetic), Important classification of taxonomy(Engler prantl, Bentham and hooker)
18Hours	**The species concepts:** Taxonomic hierarchy, species, genus, family and other categories, principles used in assessing relationship, delimitation of taxa and attribution of rank. Concept of typification. **Taxonomic evidence:** Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry, Genome analysis and nucleic acid hybridization.
18 Hours	**Taxonomic tools:** Herbarium(Concept and method of preparation), floras, Biological diversity-concepts and applications. Important botanical garden and herbaria. **Monocotyledons:** Microspermae,Epigynae,Coronarieae, Calycineae and Glumaceae.
18Hours	**Dicotyledons:** Order-Ranales, Peritales, Caryophllales,Malvales, Rosales,Passiflorales, Umbellales,Myrtales, Rubiales, Asterales, Gentiales, Polymoniales, Lamiales, and Unisexuales.
18Hours	**Systems of angiosperm classification:** Phenetic verses phylogenetic systems, cladistics in taxonomy, relative merits and demerits of major systems of classification, relevance of taxonomy to conservation.

LABORATORY WORK(PD3-902)	1. Live plants/Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APGII, 2003): Basal angiosperm and magnokids: Monocots: Commelinids: Basal Eudicots and Caryophyllids: Ranunculaceae, Rosids: Asterids. 2. Techniques in molecular systematics. 3. Phylogenetic analyses using PAUP. 4. Local flora study. 5. Basice of GIS, Remote sensing data-visual and digital interpretation for vegetation type, delineation of ecosystem using RS and GIS technology, temporal dynamics and models.
SUGGESTED READINGS	1. Angiosperm Phylogeny group (2003) An update of the angiosperm phylogeny group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141:399-436. 2. Cracknel AP, Hayes L (2009) Introduction to Remote sensing. CRC press, Boca Raton, USA (special Indian edition). 3. Crawford DJ (2003) Plant molecular systematic. Cambridge University press, Cambridge,UK. 4. Cronquist A (1981) An integrated system of classification of flowering plants. Columbia university press.New York. 5. Hollingsworth PM, Bateman RM and Gornall RJ (1999). Molecular systematic and plant evolution. Taylor and Francis, London. 6. Judd WS, Campbell CS, Kellogg EA, stevens PA and Donoghue MJ (2002) Plant systematic: A Phylogenetic approach, sinauer associates, Inc, Massachusetts. 7. Nei M and kumar S (2000) molecular evolution and phylogenetics. Oxford university press.New York. 8. Raven PH, Begr LR, Hassenzahl DM (2008) environment. 6th edition John wiley& Sons, Inc. New York. 9. Semple C and Steel MA (2003) Phylogenetics. Oxford university press, oxford. 10. Simpson MG (2006) Plant systematic. Elsevier, Amsterdam. 11. Stuessy TF (2008) Plant Taxonomy: The systematic evaluation of comparative Data. Columbia university press, New York. 12. Swafford DL (2001) PAUP. Phylogenetic analysis using parsimony (and other methods), version 4. Sinauer Associates, Sunderland.

Principles of Ecology

(Course Code: - PD3-903)

Course Outcome: – After completion of this course-

Co1 – Student will be able to understand the growth and characteristics of population and limiting factors which are affect the population.

Co2 – Student will have developed knowledge about structure and function of ecosystem. They also will understand about bio geo chemical cycle in environment and its role.

Co3 – Student will be able to understand the vegetative organization in community. Student will get to know analytical and synthetic characters of community.

Co4 – Student will have developed knowledge about Biological conservation and its management by in situ and ex-situ conservation.

Co5 – Student will get knowledge about local plant diversity and its socio-economic importance.

Co6- Student will differentiate the Hydrophytes, Xerophytes and Halophytes on the basis of Anatomical characters.

Co7- Student will understand the difference in pH in different soil and can determine Frequency, density and abundance of plant community.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1				√			
PO2	√		√			√	
PO3							
PO4		√					
PO5					√		√
PO6			√				
PO7							
PO8				√			√

M.Sc. (BOTANY)		IIIRD SEMESTER	
COURSE CODE: PD3-903PAPER - III		COURSE TYPE: CCC	
COURSE TITLE: PRINCIPLES OF ECOLOGY			
CREDIT:6+3		HOURS:90	
THEORY: 6	PRACTICAL:3	THEORY:90	PRACTICAL: 45
MARKS			
THEORY: 100 (70+30)		PRACTICAL:100/2	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word).

18 Hours	Introduction to ecology, evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure, population growth.
18Hours	Ecosystem structure and its component, Nature of ecosystem, production, food chain and food webs, energy flow through ecosystem, Ecological pyramid, biogeochemical Cycles-C,N, P, S, ecosystem management. The biosphere, biomes and impact of climate on biomes. Litter decomposition.
18 Hours	**Vegetation organization:** Concepts of community and continuum, analysis of communities (analytical and synthetic characters),Community interaction,, concept of ecological niche, Ecotone, Ecotype, Law of tolerance, succession, types and its model
18Hours	**Biological conservation and management, conservation**-Red data book, ICUN classification and categories. **In situ conservation:** Protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity. **Ex-situ conservation:** Principles and practices; botanical gardens, field gene banks, seed banks, cryobanks.
18Hours	**Concepts of Phytogeography:** Endemism, Hotspots and hottest hotspots, flagship, Umbrella and keystone species, invasions and introduction of invasion biology, local plant diversity and its socio-economic importance.

LABORATORY WORK PD3-903)	1. Physical and chemical characters of soil. 2. Assessing influence of light, temperature and moisture on plant germination and growth/animal behaviour and growth. 3. Assessing influence of soil nutrient status on plant germination and growth Community/ecosystem studies: 1. Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrate etc. 2. Comparison of stands/communities and ordination. 3. Profile diagrams. 4. Biomass and reproductive allocation under various environments. 5. Nutrient uptake and budget for various communities/Food chain assessment. 6. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro, and macro fauna in decomposition. 7. Understanding ecosystem succession by studying various stages of vegetation/community assemblage's development. 8. Molecular techniques in laboratory. 9. Insect diversity in soil Landscape studies: 4. Principles of GIS and RS technology. 5. Interpretation (visual and automated) of remote sensing information for landscape differentiation.
SUGGESTED READINGS	1. Conklin, A.R. Jr. 2004. Field Sampling: Principles and Practices in Environmental Analysis. 2. Fahey, T.J. and Knapp, A.K. 2007. Principles and Standards for Measuring Primary Production. Oxford. 3. Grant, W.E. and Swannack, T.M. 2008. Ecological Modeling. Blackwell. 4. Wilkinson, D.M. 2007. Fundamental Processes in Ecology: An Earth system Approach. Oxford.

Intellectual property rights

(Course Code: - PD3-904)

Course Outcome: - This course is an optional but compulsory for completion of the degree student can correlate the knowledge gained in this subject with his principle subject. This gives an opportunity to learn other subjects of his interest which is not offered in his principle subject.

Course level learning outcome:-

After the completion of the course, students will be able to understand:-

Co-01:- The concept and development of all forms of I.P.R.

Co-02:- Distinguish and explain various forms of I.P.R.

Co-03:- Identify criteria's to fit one's own intellectual work in particular forms of I.P.R.

Co-04:- Apply statutory provisions to protect particular forms ofI.P.R.

Co-05:- Apply the concept and forms of I.P.R. in research field.

OBJECTIVE: -The main object of this paper is to introduce the students to the various concepts of Intellectual Property i.e. Copyright, Patent, Trademark, Geographical Indication & Design. The paper also aims to familiarize the students with the procedure of filing of patents and trademark in India. The students will be able to understand various remedies available for infringement of Intellectual property and critically examine the emerging issues in I.P.R.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	√	√	√				
PO2	√						
PO3			√	√			
PO4					√		
PO5				√			
PO6		√		√			
PO7							
PO8					√		

M.Sc. (BOTANY) SEMESTER			**IIIRD**
COURSE CODE: PD3-904PAPER - IV			**COURSE TYPE: OSC**
COURSE TITLE: INTELLECTUAL PROPERTY RIGHTS			
CREDIT:6		**HOURS:90**	
THEORY: 6	**PRACTICAL: 0**	**THEORY:90**	**PRACTICAL: 00**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:00**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word).

18 Hours	**Introduction, Nature, Basic Concepts and International Conventions :** Nature and meaning of Intellectual Property, Justification for protection of Intellectual Property Rights, Types of Intellectual Property, Leading International instrument concerning protection of Intellectual Property: The Berne Convention (1886), Rome convention (1961) Trade Related intellectual property agreement, 1995 (TRIPS)
18Hours	**Law of Copyright** Definition, Subject matter of copyright, Ownership of Copyright, Term of Copyright, Rights of Owner, Assignments and Licenses, Infringement of Copyright , Remedies against infringement of copyright
18 Hours	**Law of Patents** Meaning , Criteria for obtaining patents- *Novelty*, *Utility*, *Non-obviousness* Non-patentable inventions, Procedure for Registration, Term of patent, Rights of Patentee, Compulsory licensing and Government use of patent, Infringement of patent, Remedies in case of Infringement
18Hours	**Law of Trademark** Meaning of mark & Trademark, Categories of Trademark- Conventional and Non-conventional Marks , Concept of distinctiveness, Doctrine of honest concurrent use, Procedure of registration of trademarks and Term of Protection, Absolute and relative grounds for refusal of registration, Assignment and Licensing, Infringement and Passing off.

18Hours	**Geographical Indication (GI) and Design:** 1. Geographical Indication- Meaning of GI, Difference between GI and Trademark & Concept of Authorized user 2. Designs- Meaning of Design Protection, Concept of original design, Term of Protection
SUGGESTED READINGS	1. V.K Ahuja, *Law Relating to Intellectual Property Rights*, Lexis Nexis, Haryana, India. 2. G.B.Reddy, *Intellectual Property Rights and Law*, Gogia Law Agency, Hyderabad. 3. S.R.Myneni, *Intellectual Property Law*, Eastern Law House, Calcutta 4. P. Narayanan *Intellectual Property Rights and Law (1999)*, Eastern Law House, Calcutta, India 5. VikasVashistha, *Law and Practice of Intellectual Property*, (1999) Bharat Law House, New Delhi. 6.GyanvatiDhakad, BaudhikSampadaVidhiyan (Intellectual Property Laws- Hindi),Central Law Publication.

Pathogen and pests of crop plants

(Course Code: - PD3-905)

Course Outcome: - After completion of this course -

Co1 – Student will understand the characteristics of microorganism like fungi, Bacteria and viruses. They will also develop knowledge their parasitic ability and damage caused by them.

Co2 – Student will get knowledge about symptom of plant diseases and they will also know about pathogenesis.

Co3 - Student will get knowledge about the source of infection and they will also get know about the recurrence of diseases.

Co4- Student will be able to know the importance of environment and nutrition on disease development. They will also get knowledge about how to pathogen disseminate.

Co5-Student will be able Understand the techniques and good lab practices for working in a laboratory and develop skill in slide Preparation of plant disease.

Co6- Student will be able Develop skills for identifying fungal genera and fungal disease on the basis of symptoms, using them for industrial and laboratory purposes.

C06-Student can initiate his own fungal culture laboratory and enterprise on fungal products.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1		√	√	√		√	
PO2	√	√					
PO3							
PO4							
PO5					√		√
PO6			√				√
PO7					√		
PO8				√		√	

M.Sc. (BOTANY) SEMESTER			**IIIRD**
COURSE CODE: PD3-905PAPER - V		**COURSE TYPE: ECC**	
COURSE TITLE: PATHOGENS AND PESTS OF CROP PLANTS			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word).

18 Hours	**General characteristics of pests including viruses:** General characteristics of fungi, bacteria and viruses, their hetrotrophic behaviour with emphasis on parasitism parasitic ability and virulence. Nature of disease (s) and damage caused.
18Hours	**Symptomatology:** General symptoms of plant diseases, pathogenic and non-pathogenic. **Pathogenicity:** Distribution of plant pathogens, penetration and entry by plant pathogens mode of infection, inoculum and inoculums potential, Kochs postulates.
18 Hours	**Host parasite relationship:** Role of enzymes and toxins in pathogenesis. Defence of plant against pathogens, resistance and susceptibility, phytoalexin, disease syndrome. **Effect of infection on the physiology of the host:** Permeability, photosynthesis, respiration.
18Hours	**Effect of environment:** Predisposition and stress, epidemiology and disease forecasting, source of infection i.e. seed, soil, water and air born diseases of plants, significance of phyllosphere and rhizosphere studies, recurrence of diseases.
18Hours	Effect of environment and nutrition on disease development. Dissemination of plant pathogens.

LABORATORY WORK(PD3-905)	1. Methods of sterilization; Media preparation (selective media); inoculation procedures. 2. Characterization of disease symptoms and identification of pathogenic organisms. 3. A study on effects of various formulation and doses of BTK on growth and development of selected pest species. 4. Isolation and identification of rhizosphere soil fungi, seed borne fungi. 5. Isolation and estimation of DNA from fungus. 6. Biochemical markers of enhanced resistance. (i) Estimation of total phenols and O-di hydroxy phenols in sugarcane and groundnut. (ii) Estimation of activity of Phenylalanine ammonia lyase in healthy and diseased leaves of sugarcane. (iii) Estimation of deoxyribonuclease and ribonuclease enzymes produced by virus infectedand healthy leaves of tobacco. 7. Research paper discussions.
SUGGESTED READINGS	1. Agrios GN (2005) Plant Pathology, 5th Edition. 2. Buchanan B, Gruissem G and Jones R (2000) Biochemistry and Molecular Biology ofPlants", American Society of Plant Physiologists, USA.

- **M. Sc. in BOTANY** **FACULTY OF SCIENCE**
- **FOURTH SEMESTER** (EVEN SEMESTER)

Eligibility Criteria (Qualifying Exams)	Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per Week			EoSE Duration (Hrs.)	
					L	T	P	Thy	P
After appearing in the Third semester examination irrespective of any number of back/ arrear papers	PD3-1001	CCC	**PLANTS TISSUE CULTURE AND INDUSTRIAL APPLICATIONS**	6	4	2	00	3	00
	PD3-1002	CCC	**BIOTECHNOLOGY, GENETIC ENGINEERING AND RESOURCE UTILIZATION**	6	4	2	00	3	00
	PD3-1001&PD3-1002	CCC	**LAB – C :- PLANTS TISSUE CULTURE AND INDUSTRIAL APPLICATIONS & BIOTECHNOLOGY, GENETIC ENGINEERING AND RESOURCE UTILIZATION (PRACTICAL)**	3	00	00	3	00	3
	PD3-1003	CCC	**PLANT PATHOLOGY-DISEASES OF PLANTS**	6	4	2	00	3	00
	PD3-1003& PD3-1005	CCC ECC/CB	**LAB D :- PLANT PATHOLOGY-DISEASES OF PLANTS&EMBRYOLOGY AND REPRODUCTIVE BIOLOGY OF FLOWERING PLANTS (PRACTICAL)**	3	00	00	3	00	3
	PD3-1004	SSC/PRJ	**DISSERTATION**	6	00	00	9	00	4
	PD3-1005	ECC/CB	**EMBRYOLOGY AND REPRODUCTIVE BIOLOGY OF FLOWERING PLANTS**	6	4	3	00	3	00
	PD3-1006	ECC/CB	ADVANCED PLANT SYSTEMATICS						
	PD3-1007	ECC/CB	CONTEMPORARY CONCEPTS AND METHODS IN CELL BIOLOGY						
	PD3-1008	ECC/CB	PLANT PHYSIOLOGY AND BIOCHEMISTRY						
	MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN TOTAL IT WOULD BE 30			TOTAL = 33					

Plant tissue culture and Industrial Applications

(Course Code:- PD3-1001)

Course outcome:- After successful completion of this course –

Co1 – Student will understand the concept of tissue culture. They will have developed knowledge of micro propagation of different types of plants through tissue culture.

Co2 – Student will get knowledge about the protoplast research about the regeneration of plants. They will understand the importance and method of in vitro and in vivo conservation.

Co3 – Student will have knowledge about the different Application of plant tissue culture. They will also develop understanding the role of minerals and hormone in organs development in laboratory.

Co4 – Student will be able to know the fundamental of organ culture. They will also get knowledge about the techniques and utility of organogenesis.

Co5 – Student will be able to practice and learn the method of different type of culture media preparation. They will also get knowledge of application of tissue culture.

Co6- Student will be able to understand the instruments and techniques of biotechnology and Tissue culture laboratory.

Co7-Student will be able to start own enterprises of improved Plant Varieties and can produce Transgenic Crop.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1		√	√				
PO2	√	√					
PO3							
PO4							
PO5			√		√		√
PO6							√
PO7					√	√	
PO8				√			

M.Sc. (BOTANY)		IVTH SEMESTER	
COURSE CODE: PD3-1001PAPER – I COURSE TYPE: CCC			
COURSE TITLE:PLANTS TISSUE CULTURE AND INDUSTRIAL APPLICATIONS			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL: 3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

x. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

xi. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

xii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Plant cell and tissue culture:** General introduction and Requirement of plant tissue culture, Sterilization and its types, Media and its component, types of media,Steps of Plant tissue culture. scope of Plant tissue culture.
18Hours	**Culture systems:**Concept of totipotency, cellular differentiation and organ differentiation, physiological, biological and molecular role of minerals and Growth Regulator in understanding differentiation of organs under in vitro conditions. **Culture Techniques:** Cell Suspension Cultures, callus Culture and Single Cell Culture,Production of hybrids and cybrids.
18 Hours	**Somatic hybridization:** Protoplast isolation, fusion and culture, hybrid selection and regeneration. Possibilities, achievements and limitation of protoplast research. Micro propagation (Via organogenesis and embryogenesis) Germplasm conservation in vitro and vivo.
18Hours	**Organogenesis and adventative embryogenesis:** Fundamental aspects of morphogenesis, embryogenesis and androgenesis. Mechanism, techniques and utility of morphogenesis and ambryogenesis.
18Hours	**Application of plant tissue culture:** Clonal propagation, somaclonal, artificial seed,hybrids and cybrids, cryopreservation and germplasm storage.

LABORATORY WORK(PD3-1001)	1. Development of regeneration protocols employing direct and indirect organogenesis /somatic embryogenesis in economically important horticultural and/or medicinal plants. 2. Control of phenolics in recalcitrant tissues under culture conditions. 3. Study of various physico-chemical factors (pH, light, hormones, etc.) on in vitro growth and development of tissues or organs, rooting of regenerants, in vitro and ex vitro hardening, potting and acclimatization in natural conditions. 4. Shoot-tip meristem culture for raising virus-free plants in tomato / tobacco. 5. *Agrobacterium rhizogenes*mediated development of hairy root cultures. 6. Isolation of bioactive compounds from medicinal plants using column chromatography and TLC. 7. Preparation of synthetic seeds for germplasm conservation using somatic embryos or other propagules.
SUGGESTEDREADINGS	1. Herman EB (2008) Media and Techniques for Growth, Regeneration and Storage 2005- 2008. Agritech Publications, New York, USA. 2. Pierik RLM (1999) *In Vitro* Culture of Higher Plants. Kluwer Academic Publishers. 3. Prakash J &Pierik RLM (1991) Horticulture - New Technologies and Applications (Current Plant Science and Biotechnology in Agriculture). Kluwer Academic Publishers. 4. George EF, Hall MA and Geert-Jan De Klerk (2008). Plant Propagation by Tissue Culture (3rd Edition), Springer, Netherlands. 5. Journals: Plant Cell, Tissue and Organ Culture, Plant Cell Reports.

Biotechnology, Genetic Engineering and Resource Utilization

(Course Code: - PD3-1002)

Course outcome: - After successful completion of this course-

Co1 – Student will get knowledge about Importance of recombinant DNA technology. Student will get idea about gene cloning and DNA libraries.

Co2 – Student will have knowledge about the technique and importance of DNA fingerprinting and PCR.

Co3 – Student will know how they can grow disease free plant by tissue culture technique. They will develop understanding about how gene technology has helped in improving various qualities in crops.

Co4 – Students will know the characters of Agro bacterium and they will get knowledge about how agro bacterium used for developing a transgenic plants by genetic engineering.

Co5 – Students will have developed the knowledge of genetic improvements of microbes for Industrial important. They will get idea about fermentation technology.

C06- Students will understand the instruments and techniques of biotechnology and enhance learning skill for the operation of tools and techniques of genetic engineering.

Co7-Students can start own enterprises of improved Plant Varieties and can produce Transgenic Crop.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1		√					
PO2	√	√		√			
PO3							√
PO4							
PO5			√				
PO6			√				√
PO7						√	
PO8					√	√	

M.Sc. (BOTANY)		IVTH SEMESTER	
COURSE CODE: PD3-1002PAPER - II		**COURSE TYPE: CCC**	
COURSE TITLE: BIOTECHNOLOGY, GENETIC ENGINEERING AND RESOURCE UTILIZATION			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

ii. Middle Answer type questions: Three questions carrying 9 Marks each to be set asked two to be attempted. (Word Limit 250 Word)

iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	**Biotechnology:** Basic concepts, principles, scope and application.Salient Achievement of Biotechnology. **Biotechnology (Plant breeding):** -Plant Breeding in concept of Crop Improvement, Method of Crop Improvement, Conservation of Plant Genetics Resource.
18Hours	**Recombinant DNA technology**: Requirements of RDT (Enzymes and vector); Introduction of DNA into host; Agrobacterium mediated transformation, plant agrobacterium interactions; direct gene transfer methods,T- DNA and transposon mediated gene tagging; chloroplast transformation and its utility. Marker and reporter genes, Selection of transformed cell and recombinant screening Transgenic plants or GM plants.
18 Hours	**Genetic Engineering:** DNA fingerprinting;Gene cloning principles and techniques; PCR (types and principle) DNA libraries; DNA sequencing and genome mapping.Application of Genetic engineering. Genomics, Proteomics, Glycomics, Bioinformatics
18Hours	**Microbial genetic manipulation:** Bacterial transformation selection of recombinants and transformants, genetic improvements of industrial microbes, nitrogen fixers, fermentation technology.

18Hours	**Instrumentation and Techniques**: Electrophoresis (agarose and PAGE); Chromatography: principle and its types; Microscopy (Light and electron microscopy, SEM and TEM); Blotting Techniques, Microarray
LABORATORY WORK (MBT203)	1. Preparation of different types of standard tissue culture media. 2. Establishment of aseptic cultures following appropriate sterilization procedures using seeds. 3. Preparation of competent cells and agrobacterium transformation by electroporation. 4. Agrobacterium tumefaciens mediated transformation of tobacco. 5. Visualization of GFP or YFP in transgenic Arabidopsis. 6. Morphological and histochemical features of major cereals, oilseeds, legumes, forest trees, non-alcoholic beverages and medicinal plants. 7. Analysis of crude extracts from medicinal plants using HPLC. 8. Evaluation of a transgenic phenotype (viz., Herbicide resistance) under containment conditions in the field.
SUGGESTEDREADINGS	1. Adrian S, Nigel WS, Mark RF (2008) Plant Biotechnology: The genetic manipulation of plants, Oxford university press. 2. Buchanan B, Gruissem G and Jones R (2000) Biochemistry and Molecular Biology of plants, American society of plant physiologists, USA. 3. Butenko RG (2000) plant cell culture, university press of pacific. 4. Davies PJ (2004) plant Hormones, Kluwer academic publishers, Netherlands. 5. Halford N (2006) plant Biotechnology- current and future applications of genetically modified crops, John Wiley and Sons, England. 6. Wickens GE (2004) Economic Botany: Principles and practices, Springer, ISBN 978-0-7923-6781-9.

Plant pathology and diseases of plants

(Course Code: - PD3-1003)

Course outcome –After completion of this course –

Co1 – Students will get knowledge about the production of new races of fungi which are more harmful for host plants. They will get to know different control measure of plant diseases and quarantine procedure.

Co2- Student will understand the characteristics of microorganism like fungi, Bacteria and viruses. They will also develop knowledge their parasitic ability and damage caused by them.

Co3 – Students will have developed the knowledge of different disease of vegetable caused by viruses, nematodes and mycoplasma. They will also understand how these diseases control.

Co4 – Student will get knowledge about symptom of plant diseases and they will also know about pathogenesis.

Co5- Student will be able to know the importance of environment and nutrition on disease development. They will also get knowledge about how to pathogen disseminate.

Co6-Student will be able Understand the techniques and good lab practices for working in a laboratory and develop skill in slide Preparation of plant disease.

Co7- Student will be able Develop skills for identifying fungal genera and fungal disease on the basis of symptoms, using them for industrial and loboratory purposes.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	√						
PO2	√	√	√		√		
PO3							√
PO4					√		
PO5							√
PO6			√	√			
PO7						√	
PO8							

M.Sc. (BOTANY)		**IVTH SEMESTER**	
COURSE CODE: PD3-1003PAPER - IIICOURSE TYPE: CCC			
COURSE TITLE:PLANT PATHOLOGY-DISEASES OF PLANTS			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL: 45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

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iii. Long Answer type questions: Five questions carrying 14 Marks each to be set three to be attempted. (Word Limit 700 Word)

18 Hours	Introduction to biotic interactions with plants. Genetic of host interaction, physiological specialization, production of new races, adaptation of fungi to different hosts. **Control of plant diseases:** Principles of plant disease control, methods of control e.g. regulatory chemical: Biological and breeding of resistant varieties of host plants, plant quarantine.
18Hours	Recent advances in plant-bacteria, interactions: Stages of pathogenesis: citrus canker, bacterial blight of cotton, bacterial leaf blight disease of rice, bacterial brown rot or wilt disease of potatoes, bacterial Rot of wheat ears (tunda disease).
18 Hours	Recent advances in plant fungi interaction stages of pathogenesis: diseases caused by phycomycetes-wart disease potato, damping-off of seedlings, fruit rot of cucurbits, Rhizome rot of ginger, green ear disease of bajra, downy mildew of pea. Diseases caused by ascomycetes-stem galls of coriander, peach leaf curl, leaf spot of turmeric, ergot of bajra, false smut of paddy, stem rot of paddy.

18Hours	Diseases caused by basidiomycetes (the smut) loose smut of wheat, covered smut of barley, bunt or stinking smut of wheat, leaf smut of rice, flag smut of wheat. Diseases caused by fungi-imperfecti-leaf spot or helminthosporium disease of rice, blast of rice, red rot of sugarcane, wilt of pigeon pea, wilt of cotton, wilt disease of linseed.
18Hours	Diseases caused by virus, nematodes, mycoplasmas-viral disease-yellow vein mosaic of Bhindi, bunchy disease of banana. Mycoplasma and plant disease-sandal spike, grassy shoot disease of sugarcane, little leaf of brinjal. Disease due to nematodes-root knot f vegetables, molya disease of barley and wheat, ear-cockle of wheat.
LABORATORY WORK (PD3-1003)	1. Study on susceptible and resistance interactions at cellular and biochemical levelsbetween plants and pathogens, and between plant and pests. 2. Investigation of infection cycle of a plant parasitic nematode (e.g., root knot nematode,*Meloidogyne incognita*) in susceptible and resistant tomato roots in the absence andpresence of resistance genes (Mi gene). 3. Estimation of activity of phenylalanine ammonia lyase in healthy and disease leaves. 4. Detection of plant viruses from infected leaf tissues using ELISA and Western Blot. 5. Computer-based study of a multigene family pathogenicity gene from the Nem databases. 6. Field visit to show diseases on crop plants.
SUGGESTEDREADINGS	1. Williamson VM, Kumar A (2006) Nematode resistance in plants: the battle underground. *Trends in Genetics* 22: 396–403. 2. Davis EL, Hussey RS, Baum TJ (2004) Getting to the roots of parasitism by nematodes. *Trends in Parasitology* 20: 134–141. 3. Plant Nematology (2006) Edited by Perry and Moens, CABI. *Plant virology and insect-plant interactions:* 4. Induced responses to herbivory by R Karban and IT Baldwin (1997) Chicago University Press, Chapter 3, pg47-100. 5. Mathew's Plant Virology by Roger Hull (2001) Academic Press, NY. *Plant-fungi interactions:* 6. *Plant resistance mechanisms (SAR, ISR)* - Strange RN, (2003) Introduction to Plant Pathology, John Wiley & Sons, USA. 7. *Signal transduction; Molecular diagnostics; Transgenic approaches for crop protection* - Dickinson M, (2003) Molecular Plant Pathology, Bios Scientific Publishers, London.

Embryology and Reproductive Biology of Flowering Plants

(Course Code: - PD3-1005)

Course outcome –After completion of this course –

Co1 – Student will understand the floral architecture and the process of flower development.

Co2 – Students will understand the structure of Anther and development of pollen and biochemical aspects of pollen. They will also know about the development of male and female gametophyte.

Co3 – students will understand pollination mechanism. They get to know about fertilization and how pollen stigma interaction takes place. They will also understand the concept of Incompatibility.

Co4 – Student can understand the relation between embryo and endosperm. Student will get idea about practical importance of polyembryony. Student will develop understanding of formation of embryo from somatic cell.

Co5 – Students will get knowledge about the types of fruits and their biochemistry during maturation students will also understand how endosperm provide nutrition to embryo development. They also understand how germination of seed takes place in plants.

Co6- Students will understand the techniques and lab practices for working in field of taxonomy andpreparation of Herbarium.

Co7- Students can make own herbaria of that region and can start own food resource utilization centre.

PO-CO Mapping

PO	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1					√		
PO2	√	√	√	√			
PO3							
PO4						√	√
PO5			√				
PO6							√
PO7						√	
PO8							

M.Sc. (BOTANY)		IVTH SEMESTER	
COURSE CODE: PD3-1005PAPER - VCOURSE TYPE: ECC			
COURSE TITLE: EMBRYOLOGY AND REPRODUCTIVE BIOLOGY OF FLOWERING PLANTS			
CREDIT:6+3		**HOURS:90+45**	
THEORY: 6	**PRACTICAL:3**	**THEORY:90**	**PRACTICAL:45**
MARKS			
THEORY: 100 (70+30)		**PRACTICAL:100/2**	

Scheme of Marks:

i. Short Answer type questions: Three questions carrying 5 Marks each to be asked two to be attempted. (Word Limit 100 Word)

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18 Hours	**Modes of Reproduction:** An overview **Flower development:** Regulation of floral architecture and diversification; Floral organogenesis; Pollination regulation of flower development.
18Hours	**Male gametophyte:** Structure of anthers, microsporogenesis, role of tapetum, pollen development , male sterility, sperm dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. **Female gametophyte:** Ovule development, megasporogenesis, types of Embryo sacs, Structure of Embryo sac, Haustorial behaviour of Embryo sac.
18Hours	**Pollination, pollen-pistil interaction and fertilization:**Self-Pollination, Cross-Pollination, Pollen Storage, pollination mechanisms and vectors, breeding systems, structure of the pistil, pollen stigma interactions, self-incompatibility, double fertilization, in vitro fertilization.
18Hours	**Plant-pollinator interactions and Embryogenesis:** Plant-pollinator interaction: pollen load, pollination energetics, apomixes, embryogeny in dicotyledons; and in monocotyledons; polyembryony, somatic embryogenesis.

18Hours	**Fruit biology:** Development biology and diversity of fruit types, Dynamics of fruit growth, biochemistry and molecular biology of fruit maturation **Seed biology:** Endosperm development during early maturation stages, embryogenesis ultra-structure and cytology, seed development pattern, parthenocarpy, pseudogamy and autonomous development of endosperm; Embryo and endosperm culture.
LABORATORY WORK(PD3-1005)	1. Study of developmental aspects of reproduction using Arabidopsis mutants. 2. Isolation of embryo sacs and visualization of post-fertilization stages with the help of fluorescence and confocal microscope. 3. Study of micro and megasporogenesis using nomarski interference microscope. 4. Microtomy of resin-embedded and wax-embedded material. 5. Determination of mating systems using Isozymes/DNA markers. 6. Study of pollination syndromes and plant-pollinator interaction. 7. Measuring floral sex allocation based on biomass. 8. Assessment of floral rewards: quantitative and qualitative analysis of nectar and pollen. 9. Assessment of attraction of insects to artificial flowers and determining pollination energetic. 10. Demonstration of in-situ expression of anther/ovule specific genes. 11. Induction of somatic embryos using a suitable plant material. 12. Study of types of embryo sacs during apomictic development by employing ovole-clearing method.

SUGGESTED READINGS	1. Barrett SCH (2008) Major evolutionary transitions in flowering plant reproduction. Univ. of Chicago press. 2. Faegri K & van der pijl L (1979), The principles of pollination ecology. Pergamon press. 3. Harder LD & barrett SCH (2006) ecology and evolution of flowers, oxford univ. press. 4. O Neill SD & Roberts JA (2002) plant reproduction, Sheffield academic press. 5. Raghavan V (1997) molecular embryology of flowering plants,Cambridge univ. press. 6. Raghavan V (2000) developmental biology of flowering plants, springer V erlag, New York. 7. Richards AJ (1986) plant breeding system, George allen and unwin, UK. 8. Scott RJ and stead AD (2008) molecular and cellular aspects of plant reproduction. Society for experimental biology, seminar series 55. 9. Shivanna KR and johri BM (1985) the angiosperm pollen: structure and function. New Delhi, India: Wiley-eastern. 10. Shivanna KR and Rangaswamy NS (1992) pollen biology: A laboratory manual, springer-V erlag, Berlin.