Fergusson College (Autonomous) Pune

Learning Outcomes-Based Curriculum

for M.Sc. I - Botany

With effect from June 2019

Program Structure

Semester	Course Code	Course Title	Course	No. of credits
I	BOT4101	Fundamental Botany - I	TCore-1	04
	BOT4102	Plant Physiology and Biochemistry	TCore-2	04
	BOT4103	Genetics and Evolution	TCore-3	04
	BOT4104	Botany Practical - I	PCore-1	04
	BOT4105	Botany Practical - II	PCore-2	04
II	BOT4201	Fundamental Botany - II	TCore-4	04
	BOT4202	Cell Biology	TCore-5	04
	BOT4203	Molecular Biology and Genetic Engineering	TCore-6	04
	BOT4204	Techniques in Biology **OR**	D Elect-1	04
	BOT4205	Molecules of life and biophysical parameters (MOOCS)	M Elect-1	04
	BOT4206	Botany Practical - III	PCore-3	04
	BOT4207	Botany Practical - IV	PCore-4	04
III	BOT5301	Fundamental Botany III	Special-1	04
	BOT5302	Plant Biotechnology	Special-2	04
	BOT5303	Plant Ecology	D Elect-2	04
		Environmental Law	M Elect-2	04
	BOT5304	Industrial Botany	D Elect-3	04
		Biomolecules: Structure, function in health and disease	M Elect-3	04
	BOT5305	Botany Practical V	P Special-1	04
	BOT5306	Botany Practical VI	P Special-2	04
IV	BOT5401	Biostatistics and Bioinformatics	D Elect-4	04
		Biostatistics	M Elect-4	04
	BOT5402	Research Project And Summer Training	P Special-3	08

Programme Outcomes

PO1	**Diversity study** - Acknowledge the diversity of various plant groups, recognize the classes and analyse relationship between them and their ecological implications.
PO2	**Environment conservation and sustainability** - Understand the impact of human activity on nature, importance of conservation and its role in sustainability.
PO3	**Problem analysis** - Identify, formulate research literature and ability to assess problems and probable solutions for conservation of biodiversity and create awareness on sustainable development.
PO4	**Techniques** - Select and apply appropriate techniques to solve and analyze problems with special reference to biological techniques and instrumentation.
PO5	**Individual and team work** - Function effectively as an individual and as a member or leader of group to fulfil the responsibilities.
PO6	**Communication** - Communicate effectively on topics in biological sciences with special references to plant sciences and ability to correlate it with society at large. Write effective reports (general and research) and make presentations and communicate them effectively.
PO7	**Lifelong Learning** - Acquire ability for self learning, discipline and taking logically correct approach for solving problems.
PO8	**Interdisciplinary approach** - Identify inter relationships between different fields of science and interpret their correlation.
PO9	**Research** - Use research based knowledge and research methods to design the experiment, interpret the data and provide valid conclusion.

Semester I

BOT4101 Fundamental Botany - I

Credits: 4

Course Outcomes The learner: • Recognizes the position of algae, fungi and bryophytes in the classification system • Examines any specimen obtained from the field in laboratory condition by using proper scientific methodologies • Lists out morphological and anatomical characters of lower plants • Differentiates between different habits of lower plants. • Illustrates the life-cycle strategies of cryptogams • Identifies the lower plants belonging to different orders • Classifies and identifies lower plants up to family level Will be able to draw diagrams e.g. thallus diversity, life cycle pattern, etc.	Suggested Pedagogical Processes • Use either fresh or preserved material to explain the thallus structure. • Use permanent slides to explain vegetative and reproductive anatomy • Explore surroundings with field visits accompanied by subject experts. • Discuss thallus diversity with appropriate ICT tool • Use diagrams and charts to discuss life cycle patterns • Facilitate students to collect specimens from surroundings, classify, identify, document and preserve them Discuss industrial applications of lower plants and conduct industry visits

Unit No.	Title of Unit and Contents
1	**Introduction to Algae** 1.1 An outline of general classification of algae by latest system 1.2 Cyanophyta: Ultrastructure; strategy of cell division; thallus organization 1.3 Symbiotic association of algae, Endosymbiotic Theory 1.4 Brief introduction, structural and reproductive features of Chrysophyta, Xanthophyta, Bacillariophyta, Dinophyta
2	**Diversity of Algae I** 2.1 Chlorophyta: structure and evolution of thallus, life cycle patterns, reproduction 2.2 **C**harophyta and Euglenophyta: structure and reproduction
3	**Diversity of Algae II** 3.1 Phaeophyta: general account of external and internal morphology, reproduction and life cycle patterns 3.2 Rhodophyta: general account of external and internal morphology, reproduction and life cycle patterns
4	**Commercial products prepared from algae**
5	**Introduction to Fungi** 5.1 An outline of latest classification system(Spatafora et al., 2017) Overview of a higher level phylogenetic classification of fungi (Kirk 2008 and Hibbett et al., 2007) 5.2 Taxonomy of fungi: Characters of fungi used for classification
6	**Symbiotic Fungal Associations** 6.1 Lichen: types, morphology, reproduction and uses. 6.2 Arbuscular mycorrhizal fungi: diversity and abundance. 6.3 Endophytic fungi

7	**Diversity of Fungi** 7.1 Structure, thallus organization, life cycle patterns, reproductive structures of the forms belonging to: Phyllum: Chytridiomycota, Neocallimastigomycota, Blastocladiomycota, Microsporidia, Glomeromycota, 7.2 Ascomycota: thallus organization, centrum development, different types of ascocarps 7.3 Basidiomycota: tissue differentiation, development of basidia and basidiospore, Diversity of mushrooms
8	**Bioprospecting of Fungi**
9	**Introduction to Bryophytes** 9.1 Morphological characters used for classification 9.2 Systems of classification of Bryophytes (Stotler & Stotler,2005) (Schimp)
10	**Diversity of Bryophytes** Distribution, morphological, anatomical, reproductive characters and comparative account of sporophytes and gametophytes and interrelationships along with their fossil relatives of the following orders: Calobryales, Sphaerocarpales, Marchantiales, Jungermanniales, Anthoceratales, Notothyladales, Takakiales, Sphagnales, Andraeales, Polytrichales, Buxbaumiales, Funariales.
11	**Economic Importance of Bryophytes**

Learning Resources

Algae:

1. Bellinger, E. G. and Sigee, D. C. (2010). Freshwater algae: Identification and use as bioindicators. Wiley-Blackwell, UK, pp. 271.
2. Brodie, J. and Lewis, J. (2007). (Ed.) Unravelling the algae: the past, present and future of algal systematics. CRC press, New York, pp. 335
3. Cole, K. M. and Sheath, R. G. (1990). Biology of the red algae. Cambridge University Press. USA, pp. 503.
4. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi.
5. Graham, L. E. and Wilcox, L. W. (2000). Algae. Prentice-Hall, Inc. pp. 640.
6. Krishnamurthy, V. (2000). Algae of India and neighbouring countries I. Chlorophycota, Oxford and IBH, New Delhi.
7. Lee, R. E. (2008). Phycology. Cambridge University Press, pp. 547.
8. Misra, J. N. (1966). Phaeophyceae in India. ICAR, New Delhi.
9. Prescott, G. W. (1969). The algae: A review. Nelson, London.
10. Smith, G. M. (1950). The fresh water Algae of the United States, Mc-graw Hill, Newyork.
11. Srinivasan, K. S. (1969) Phycologia India. Vol I and Vol II B.S.I. Calcutta.

Fungi:

1. Alexopolus, C. J., Minms, C. W. and Blackwell, M. (1999). (Fourth edition) Introductory Mycology, Wiley, New york. Alford, R. A. 1405130660.
2. Deacon, J. W. (2006). Fungal biology. (Fourth edition) Blackwell publishing, ISBN.
3. Kendrick, B. (1994). The fifth kingdom (paperback), North America, New York,
4. Kirk et al., (2001). (Ninth edition), Dictionary of the fungi, published Wallingford: CABI, ISBN: 085199377X.
5. Mehrotra, R. S. and Aneja, K.R. (1990). An introduction to mycology. New age publishers, ISBN 8122400892.
6. Miguel U., Richard, H. and Samuel, A. (2000). Illustrated dictionary of the Mycology, Elvira Aguirre Acosta, Publisher: St. Paul, Minn: APS press, ISBN 0890542570.
7. Webster, J. and Roland W. (2007) (Third Edition). Introduction to fungi, Cambridge

Publisher: 3rd edition, ISBN- 10: 1585100226. University Press, 978-0-521-80739-5.

Bryophytes:

1. Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok
2. Chopra, R. N. and Kumar, P. K. (1988). Biology of bryophytes. John Wiley and Sons, New York, NY.
3. Kashyap, S. R. (1932). Liverworts of the Western Himalayas and the Panjab plain (illusterated): Part 2 The Chronica Boanica New Delhi.
4. Kashyap, S. R. (1929). Liverworts Of The Western Himalayas And The Panjab Plain Part 1 Chronica Botanica New Delhi.
5. Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta Vol I, Bryophya central Book Depot.
6. Prem puri (1981). Bryophytes: Morphology, Growth and Differentiation, Atma ram and Sons, New delhi.
7. Udar, R. (1975). Bryology in India: Chronica Botanica Co., [c], New Delhi.
8. Udar, R. (1970). Introduction to bryphyta, Shashidhar Malaviya Prakashan, Lucknow
9. Watson, E. V. (1971). Structure and life of bryophytes, Hutchinson University Library London.

BOT4102 Plant Physiology and Biochemistry

Credits: 4

Course Outcomes	Suggested Pedagogical Processes
The learner, • Differentiates various metabolic pathways • Gets acquainted to basic macromolecules • Identifies role of enzymes of metabolic pathways • Describes the basic concepts of Plant Physiology in Photosynthesis and Respiration • Understands the mechanism of conduction and transport of water and minerals • Appreciates the roles of PGR's and secondary metabolites in plant growth and defence • Relates the role of light in various developmental processes Demonstrates plant responses to biotic and abiotic stresses	• Use comparative charts and hand outs for metabolic pathways • Use graphical representations for enzyme kinetics • Discuss role of important metabolites • Demonstrate live chemical reactions for explaining redox reactions. Discuss recent research papers

Unit No.	Title of Unit and Contents
1	**Biological Macromolecules** 1.1 Structure, biosynthesis and metabolism of amino acids, sugars, fatty acids, purine and pyrimidine bases 1.2 Structure, biosynthesis and metabolism of polysaccharides, lipids, proteins and nucleic acids
2	**Photosynthesis** 2.1 Photosynthetic pigments, absorption and transformation of radiant energy, Light harvesting complexes, 2.2 Kok curve, Kautsky curve, ETS, photo inhibition O_2 and H_2 evolution, regulation of Calvin cycle, RUBISCO activity, Photorespiration, 2.3 CAM, C_4 Pathway and its types 2.4 Reduction of carbon dioxide - RuBPcase and Calvin cycle, CO_2 concentrating mechanisms in C4 and CAM plants.
3	**Respiration** 3.1 Glycolysis, Kreb's Cycle, pentose phosphate pathway 3.2Organization of mitochondrial electron transport system, ATP synthesis, respiratory control, anaerobic respiration.
4	**Transport of water and minerals** 4.1Properties of water and pH. 4.2 Water uptake, transport and transpiration, stomatal physiology 4.3 Mineral nutrition of plants, Ion transport - passive and active
5	**Nitrogen metabolism** 5.1 Uptake and assimilation of nitrogen 5.2 Enzymes involved 5.3 Biological nitrogen fixation

6	**Enzymology** 6.1 Classification and properties of enzymes 6.2 coupled reactions, units of enzyme activity 6.3 Enzyme kinetics 6.4 Inhibitors, enzyme regulation.
7	**Plant growth regulators** Structure, biosynthesis, metabolism and physiological role of auxins, cytokinins, gibberellins, abscissic acid and ethylene.
8	**Photobiology** 8.1 Photoperiodism and vernalization. 8.2 Tropic and nastic movements in plants. 8.3 Structure, function and mechanisms of action of Phytochromes, Cryptochromes and Phototropins. 8.4 Stomatal movement and biological clocks.
9	**Secondary metabolites** 9.1 Major secondary metabolite synthesis pathways in plants (Alkaloids, Terpenoids and Phenolics). 9.2 Role of secondary metabolites with their applications
10	**Stress Physiology** 10.1 Physiological changes in various biotic (pathogenic) and abiotic (drought, salinity and temperature) stress conditions 10.2 Physiological role of regulators like salicylate, jasmonate, brassinosteroids and polyamines during stress

Learning Resources

1. Berg J.M., Tymoczko J.L., Stryrer L. (2002) (Fifth Edition) Biochemistry. Wlt. Freeman and Company, New York.
2. Buchanan B.B., Gruissem W., Jones R.L. (2000) Biochemistry and Molecular Biology of Plants. IK International, Mumbai.
3. Davis P. J. (Eds.) (2004) Plant Hormones. Kluwer Academic Publishers, Dordrecht, Netherlands.
4. Goodwin T.W., Mercer E.I. (1998) (Third Edition) Introduction to Biochemistry. CBS Publishers, New Delhi.
5. Heldt H. W. (2004) Plant Biochemistry. Academic Press, California.
6. Lawlor D.W. (2001) Photosynthesis in C3 and C4 Pathway. Viva, New Delhi.
7. Lincolin Taiz and Eduardo Zeiger (2010) (Fifth Edition) Plant Physiology. Sinauer Associates, Inc. Publishers. Sunder land, USA.
8. Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry. W. H. Freeman and Company. New York.

BOT4103 Genetics and Evolution

Credits: 4

Course Outcomes The learner, • Understands basic concepts of Genetics and extra chromosomal inheritance • Solves problems in Genetics and distinguishes gene interactions and interprets the result • Explains concepts of Genetics like linkage and recombination • Gets acquainted to microbial and phage genetics • Becomes familiar with mutations and chromosomal alterations Recognizes importance of evolutionary concepts	Suggested Pedagogical Processes • Diagrammatically represent inheritance patterns • Undertake problem solving activity • Use appropriate ICT tool, wherever necessary, for effective teaching • Discuss different theories of evolution Visualize chronology of geological time scale

Unit No.	Title of Unit and Contents
1	**Principles of Mendelian inheritance** 1.1 Early concepts of inheritance, discussions on Mendel's paper 1.2 Gene interactions.
2	**Cytoplasmic inheritance** 2.1 Inheritance of chloroplast genes (*Zea mays*) and mitochondria genes (Petit yeasts and cytoplasmic male sterility in plants) 2.2 Interaction between nuclear and cytoplasmic genes 2.3 Maternal effect in inheritance (*Limnaea peregra*)
3	**Quantitative inheritance and Inheritance of complex traits** Inheritance of quantitative traits and complex traits, heritability and its measurement
4	**Population Genetics** 4.1 Hardy -Weinberg's Law, factors affecting gene and gene frequencies. 4.2 Concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, adaptive radiation and modification.
5	**Recombination, Linkage and mapping of eukaryotes** 5.1 Concept of gene, allele, multiple allele, pseudo allele- complementation tests 5.2 Linkage and crossing over, Recombination, Inducing transposition 5.3 Linkage maps, lod score for linkage testing 5.4 Mapping by 3 point test cross, Mapping by tetrad analysis in Yeast (unordered) and *Neurospora* (ordered)
6	**Mutation** 6.1 Causes, detection and types. 6.2 Insertional mutagenesis, Point mutagenesis.
7	**Numerical and structural alterations of chromosomes** 7.1 Classification, method of production, identification and meiotic behaviour of aneuploids and euploids. 7.2 Deletion, duplication, inversion, translocation, complex translocation heterozygotes, Robertsonian translocations, BA translocations.
8	**Microbial Genetics** 8.1 Transformation, conjugation, transduction and genetic recombination in bacteria,

	Mapping of bacterial genome by interrupted mating, Mutant phenotypes 8.2 Genetic recombination, specialized transduction in phage, Mapping the bacteriophage genome, Fine structure analysis of rII gene in T4 bacteriophage
9	**Emergence of evolutionary thought** 9.1 Steps and preview of evolution 9.2 Lamarkism, Darwinism- neodarwinism. Concepts of variation, adaption, struggle for fitness and natural selection, Spontaneity of mutations, the evolutionary synthesis 9.3 Geological time scale
10	**Origin of cells and unicellular evolution** 10.1 Origin of basic biological molecules, Concepts of Oparin and Halden, Experiment of Miller (1953) 10.2 The first cell, origin and evolution of prokaryote, eukaryotic cells, unicellular eukaryotes, anaerobic metabolism, photosynthesis and aerobic metabolism. 10.3 RNA world theory
11	**Molecular Evolution** Concepts of natural evolution, origin of new genes and proteins, gene duplication and divergence
12	**The mechanism of evolution** Isolation mechanism, speciation, allopatry and sympatry, parapetry, convergent evolution, sexual selection, co-evolution

Learning Resources

1. Ahluwalia K.B (2005) (First Edition). Genetics New Age International Private Ltd. Publishers, New Delhi.
2. Albert B. Bray, D Lewis, J Raff, M. Robert, K. and Walter (1989), Molecular Biology of the Cell (Second Edition) Garland Publishing Inc, New York.
3. Atherly A.G., Girton J.R. and McDonald, J.F (1999). The Science of Genetics, Saunders College Publishing, Frot Worth, USA.
4. Burnham, C.R (1962). Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.

Burus and Bottino (1989). (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).

5. Busch, H. and Rothblum. L. (1982). Volume X. The Cell Nucleus rDNA part A. Academic Press.
6. Gardner and Simmons Snustad (2005) (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
7. Gupta P.K. (1988), Genetics and Cytogenetics, Rastogi Publications.
8. Hartl D.L and Jones, E.W (1998) (Fourth Edition) Genetics: Principles and Analysis. Jones and Bartlett Publishers, Massachusetts, USA.
9. Karp, G. (1999). Cell and Molecular Biology: Concept and Experiments. John Wiley and Sons, Inc., USA.
10. Khush, G.S (1973). Cytogenetics of Aneuploids. Academic Press, New York, London.
11. Lewin, B. (2000). Gene VII. Oxford University Press, New York, USA.
12. Lewis, R. (1997). Human Genetics: Concepts and Application (Second Edition). WCB McGraw Hill, USA.
13. Malacinski, G.M and Freifelder, D. (1998) (Third Edition), Essentials of Molecular Biology. Jones and B. Artlet Publisher, Inc., London.
14. Pawar C.B (2003) (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai.
15. Russel, P.J. (1998) (Fifth Edition) Genetics, The Benjamin/Cummings Publishing Company IND., USA.
16. Sariu C (2004) (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
17. Singh B.D 2004. Genetics, Kalyani Publication, Ludhiana.

18. Snustad, D.P and Simmons, M.J (2000). Principles of Genetics (Second Edition) John Wiley and Sons Inc., USA.
19. Strickberger (2005). (Third Edition) Genetics, Prentice Hall of India Pvt. Ltd., NewDelhi.
20. Verma and Agarwal (2010), Genetics, S. Chand Co, New Delhi.

BOT4104 Botany Practical - I

Credits: 4

(20P of 3Hrs)

Course Outcomes
The learner,

- Understands the range of thallus in different groups of algae
- Examines the specimens and classifies them in different groups
- Describes the variation in reproductive structures of lower plants
- Gets acquainted to industrial applications of lower plants
- Identifies and classifies the specimens upto genus level
- Develops sectioning, staining and mounting technique

Practicals based on Algae - (Any 8P of 3Hr)

Practical No.	Title
	Morphological observations, documentation (description and illustrations) andclassification according to Fritsch with reasons of taxa belonging to-
1	Chlorophyta-Unicellular to colonial forms
2	Chlorophyta- Filamentous forms
3	Chlorophyta- Parenchymatous forms
4	Charophyta,
5	Phaeophyta,
6	Rhodophyta,
7	Cyanophyta,
8	Minor Groups
9	To study different stages of *Spirulina* culture
10	To study growth curve of algae using suitable material
11	Algal herbarium Preparation
12	Alginate production from sea weeds.

Practicals based on Fungi- (Any 8P of 3Hr)

1	Study of Lichens
	Study of representative genera belonging to following subdivisions of fungi with respect to vegetative, reproductive structures and classification with reasons according to Ainsworth et al. (1973) (At least two examples from each class):
2	Myxomycotina,
3	Mastigomycotina,
4	Zygomycotina,
5	Deuteromycotina,
6	Ascomycotina,
7	Basidiomycotina
8	Isolation and culture of soil fungi/ endophytic fungi/ water fungi
9	Citric acid production and estimation by titration method
10	Isolation and identification of mycorrhizal spores
11	Study of plant pathogenic fungi

Practicals based on Bryophytes- (Any 4P of 3Hr)

1	Study of representative genera belonging to: Marchantiales- *Riccia, Cyathodium, Marchantia,* Marchantiales- *Plagiochasma, Targionia, Astrella.* Anthocerotales Funeriales
2	Study of antibacterial activity of bryophytes

BOT4105 Botany Practical - II

Credits: 4

Course Outcomes
The learner,

- Prepares solutions with appropriate concentration.
- Selects proper method of physiological and biochemical analysis of plant parts
- Interpretes the result of experiments
- Assesses the results with proper calculations and graphs
- Demonstrates the various concepts of genetics by solving problems
- Identifies various stages of mitosis and meiosis

Practicals based on Plant physiology and biochemistry- 2C (Any 10P of 3Hr)

Practical No.	Title
1	Preparation of solution of different concentrations, buffers, conductivity and pH measurements
2	Enzyme assays – extraction and estimation of enzyme activity- Catalase/ peroxidase/ invertase (Any one)
3	Effect of pH and enzyme concentrations on enzyme activity
4 & 5	Effect of substrate concentration on rate of enzyme action and calculation of Km by Michalie's Menten Curve
6 & 7	Estimation of soluble proteins in germinating and non-germinating seed by Lowry and Bradford's method
8	Estimation of ascorbic acid in ripe and unripe fruits
9	Studies on induction of amylase activity by GA_3 in germinating cereal grains
10	Estimation of reducing sugars
11	Effect of salt stress on proline accumulation and its estimation
12	Study of stomatal physiology
13	Study of effect of salt stress on overall plant physiology

Practicals based on Genetics- 2C (Any 10 P of 3Hr)

1	Preparation of somatic C- metaphase chromosomes of appropriate material
2	Study of meiotic configuration in *Rhoe*
3	Study of meiotic configuration in *Tradescantia*
4	Induction of mutation in plant material using suitable mutagen
5	Study of polygenic inheritance
6	Problems based on estimation of gene frequencies and heterozygotic frequencies, population genetics.
7	Problems based on recombination and linkage mapping
8	Study of *Drosophilla* sexual dimorphism and mutants
9	Study of monohybrid and dihybrid crosses and interactions
10	Use of Colchicine for induction of polyploidy in appropriate plant material
11	Study of fossil types

M. Sc. I Semester II

BOT4201 Fundamental Botany - II

Credits: 4

Course Outcomes- The learner: • Recognizes the position of Pteridophytes and Gymnosperms in the classification system • Examines any specimen obtained from the field in laboratory condition by using proper scientific methodologies • Lists out morphological and anatomical characters of plants • Differentiates between different habits of plants • Illustrates the life-cycle strategies • Identifies the plants belonging to different orders • Classifies and identifies plants up to family level. • Will be able to draw diagrams e.g. thallus diversity, life cycle pattern, etc.	Suggested Pedagogical Processes- • Use either fresh or preserved material to explain the thallus structure. • Use permanent slides to explain vegetative and reproductive anatomy. • Explore surroundings with field visits accompanied by subject experts. • Use diagrams and charts to describe life cycle patterns • Discuss thallus diversity with appropriate ICT tool. • Facilitate students to collect specimens from surroundings, classify, identify, document and preserve

Unit No.	Title of Unit and Contents
1	**Introduction to Pteridophytes** 1.1 Characteristic features and diversity of Pteridophytes, migration to land, affinities with Bryophytes and Algae 1.2 Recent systems of classification- PPG I, (2016)
2	**Study of pteridophytic fossil groups:** Psilopsida, Lycopsida, Sphenopsida, Pteridosperms
3	**Diversity of Pteridophytes** Comparative account of distribution, morphology, anatomy, gametophyte, sporophyte and interrelationships of following orders– Lycopodiales, Isoetales, Selaginallales, Equisetales, Psilotales, Ophioglossales, Marattiales, Osmundales, Salviniales, Pteridinae
4	**Evolution in Pteridophytes** 4.1 Apogamy, apospory 4.2 Telome theory, stelar and soral evolution, gametophyte evolution, 4.3 Heterospory and seed habit.
5	**Introduction to Gymnosperms** 5.1 Classification system of Gymnosperms (Christenhusz,2011) 5.2 Geographical distribution, characteristic features 5.3 Affinities with pteridophytes and angiosperms.
6	**Study of gymnospermic fossil groups** Progymnosperms, Pteridospermales, Cycadeoidales, Pentoxylales, Ginkgoales
7	**Evolution of seed in gymnosperms**

8	**Diversity of Gymnosperms** Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology, and interrelationships of - Cycadales**,** Ginkgoales, Welwitschiales, Ephedrales, Gnetales, Pinales, Aurocariales, Cupressales
9	**Economic importance of pteridophytes & gymnosperms**

Learning Resources:

1. Agashe SN (1995) Paleobotany, Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
2. Anold AC (2005 Repr.) An Introduction to Paleobotany, Agrobios (India), Jodhpur.
3. Bhatnagar S and Motia A (1996) Gymnosperms. New Age International, New Delhi.
4. Biswas C and Johri BM (1997) Gymnosperms. Narso. Pub., New delhi.
5. Chamberlain CJ (1986) Structure and Evolution. CBS Publishers, New Delhi
6. Eames EJ (1983) Morphology of Vascular Plants. Standard University Press.
7. Johari M, Sneh Lata and Kavita Tyagi (2012) A textbook Gymnosperm, Dominant Publishers and Distributors, New Delhi.
8. Rashid A (1999) An introduction to Pteridophyta. Vikas Publishing house Pvt. Ltd., New Delhi.
9. Sharma O P (1990) Textbook of Pteridophyta, Mac Millan India Ltd., Delhi.
10. Singh V P (2006) Gymnosperms (Naked seed plants): Structure and development, Sarup and sons, New Delhi.
11. Smith GM (1955) Cryptogamic Botany Vol. II Mc Grew Hill.
12. Sporne KR (1986) The morphology of Pteridophytes, Hutchinson University Press, London.
13. Stewart WN and Rothwell GW (2005) (Second Edition), Paleobotany and the Evolution of plants, Cambridge University Press.
14. Sundara Rajan S. (1999) Introduction to Pteridophyta, New Age International Publishers, New Delhi.
15. Surange KR (1966) Indian fossil Pteridophytes, Council of Scientific and Industrial research.
16. Parihar NS (1976) Biology and morphology of the Pteridophytes. Central Book Depot.

BOT4202 Cell Biology

Credits: 4

Course Outcomes The learner, • Appreciates important roles of cell organelles • Describes cell cycle process • Identifies different cell signalling pathways • Recognizes functional aspects of plant specific cell organelles • Explains molecular and functional aspects of various processes in cell like senescence, PCD and apoptosis. • Gets acquainted to the functioning of different signalling mechanisms	Suggested Pedagogical Processes • Use electron micrographs of cell organelles to discuss structural details • Demonstrate visualization of cell organelles and cyclosis under microscope. • Diagrammatically represent roles of cell organelles, signalling pathways and cell cycle regulation • Use audio-visual media to demonstrate function of molecules like ATP synthase.

Unit No.	Title of Unit and Contents
1	**Introduction** Cell theory and cell structure, Biogenesis of cell organelles
2	**Cell wall** 2.1 Biogenesis, ultra structure and function. 2.2 Growth - primary and secondary wall 2.3 Plasmodesmata – Structure and role in movement of molecules.
3	**Cell membranes** 3.1 Molecular organization, transport of ions and solutes across membranes 3.2 Chloroplast and mitochondrial membranes.
4	Functional aspects of cell organelles 4.1 Vacuoles - Tonoplast, biogenesis, transport across vacuolar membrane 4.2 Nucleus- Structure, organization and regulation of nuclear pore complex. Transport across nuclear membrane. 4.3 Ribosomes – Structure, assembly and dissociation of subunits, function.
5	**Secretory Pathway** 5.1 Endoplasmic reticulum- Role in synthesis and transport of Secretory proteins 5.2 Golgi complex – role in sorting, storage and secretion 5.3 Lysosomes, Glyoxysomes and Peroxisomes- structure and functions
6	**Cytoskeleton** 6.1 Composition, organization and role of microtubules, microfilaments, intermediate filaments. 6.2 Flagella- Structure and organization.
7	**Signal transduction I** 7.1 Types and functions of receptors, second messengers 7.2 Regulation of singnalling pathways, cell-cell interactions 7.3 Singnalling pathways- Phospholipid signaling, Ca^{++}-calmodulin cascade

8	**Signal transduction II** Diversity in protein kinases and phosphatases, Receptor Serine / Threonine kinase
9	**Signal transduction III** 9.1 Specific signaling mechanisms with suitable examples – biotic and abiotic stress, ABA induced stomatal closure 9.2 Nuclear-organelle signaling during plastid development, Ethylene mediated two component system 9.3 Bacterial chemotaxis and quorum sensing
10	**Cell Cycle** 10.1 Phases of cell cycle, functional importance of each phase, molecular events during cell cycle, check points, cyclins and protein kinases, MPF (maturation promoting factor), 10.2 Regulation of cell cycle 10.3 Applications of cell cycle studies.
11	**Cell senescence and PCD** 11.1 Cell aging and cell senescence 11.2 Programmed cell death- molecular aspects, regulation of cell death, PCD in response to stress
12	**Apoptosis** Role of different genes, cell organelles during apoptosis, genetic control of apoptosis.

Learning Resources

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Karp, G. 1999. Cells and Molecular Biology: Concepts and Experiments. John Wiley and Sons, Inc., USA.
3. Lodish S, Baltimore B , Berk, C and Lawrence K, 1995 , Molecular Cell Biology , 3rd edn, Scientific American Books, N.Y
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong.
5. Buchanan, Grissem and Jones, 2000, Biochemistry and Molecular Biology of Plants, American Soc. Plant Biologists, Waldorf.
6. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA
7. Cooper G M and Hausman R E, 2007, The Cell: Molecular Approach 4th Edn, Sinauer Associates, USA.

BOT4203 Molecular Biology and Genetic Engineering

Credits: 4

Course Outcomes The learner, • Understands fundamentals of molecular biology • Explains structural details of nucleic acids • Describes basic processes like DNA replication, transcription and translation • Recognizes importance of gene regulation • Relates different aspects of recombinant DNA technology • Gets acquainted to plant genetic engineering • Lists out different vectors and their uses	Suggested Pedagogical Processes • Use diagrams, charts and models. • Illustrate basic processes with appropriate ICT tools. • Use audio-visual media to demonstrate function of molecules like DNA polymerase. • Conduct visit to research institute to demonstrate genetic transfer methods

Unit No.	Title of Unit and Contents
1	**DNA-RNA structure and properties** 1.1 Types of base pairing, unusual structures 1.2 Physical, chemical, thermal, spectroscopic properties 1.3 Reassociation kinetics
2	**Packaging of genomes** Packing genomes in viruses, bacteria, organelles and nuclei.
3	**DNA replication** 3.1 DNA replication in prokaryotes 3.2 DNA replication in eukaryotes
4	**DNA Damage and Repair**
5	**Transcription** 5.1 Organization of gene 5.2 Transcription in prokaryotes 5.3 Transcription in eukaryotes
6	**RNA Processing** 6.1 Processing of tRNA and rRNA 6.2 Processing of mRNA
7	**Transcriptional gene regulation** 7.1 Operons 7.2 Phage strategies
8	**Proteins synthesis** 8.1 tRNA charging, ribosomal organization 8.2 Protein synthesis in prokaryotes 8.3 Protein synthesis in eukaryotes.
9	**Translational and Post translational gene regulation** 9.1 Post-translational processing of proteins 9.2 Proteases and their role in processing and degradation of proteins 9.3 Chaperones and protein folding.

10	**Protein targetting** 10.1 Targeting of organelle and secretory proteins. 10.2 Localisation of membrane proteins
11	**Introduction to recombinant DNA technology** 11.1 Steps in rDNA technology 11.2 Enzymes used in genetic engineering
12	**Vectors** Plasmids, Phages, Cosmids, Phagemids, BACs and YACs, Shuttle vectors, Expression vectors, Ti based vectors
13	**Plant genetic engineering** 13.1 Gene transfer methods 13.2 Factors affecting transformation, Screening for transformants, Handling transformants in subsequent generations

Learning Resources:

1. Lewin B. (2000). Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter (1999). Molecular Biology of the Cell. Garland Publishing Inc., New York.
3. Wolfe S.L (1993) Molecular and Cellular Biology, Wadsworth Publishing Co.,California, USA.
4. Rost, T. et al (1998). Plant Biology. Wadsworth Publishing Company, California, USA.
5. Krishnamurthy, K.V. (2000). Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
6. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plant. American Society of Plant Physiologist, Maryland, USA.
7. De D.N (2000). Plant Cell Vacuoles: An Introduction. CISRO Publication, Collingwood, Australia.
8. Kleinsmith L.J and Kish V.M (1995). Principles of Cell and Molecular Biology (Second Edition). Happer Collins College Publishers, New York, USA.
9. Lodish H., Berk A., Zipursky, S.L Matsudaira P., Baltimore D. and Darnell J. (2000). Molecular Cell Biology (Fourth Edition). W.H. Freeman and Company, New USA.
10. David Freifelder (1996). Essentials of Molecular Biology, Panima Publishing Company, New Delhi.
11. Brow T.A (2007) Genomes – 3 – Garland Science House, New York.
12. Malacinski G.M (2006) (Fourth Edition). Freifelders Essentials of Molecular Biology, Narosa Publishing House, New Delhi.
13. Rastogi V.B (1995) Concepts in Molecular Biology.
14. Twxman R.M (2003) (Third Reprint). Advanced Molecular Biology. Viva Books Pvt. Ltd., New Delhi.
15. Watson J.D. et al. (2004) (Fifth Edition) Molecular Biology of Gene, Benjamin and Cummings Publishing Co., California.

BOT4204 Techniques in Biology

Credits: 4

Course Outcomes The learner, • Prepares solutions of given concentration • Describes principle and working of the techniques / instrument • Selects proper technique for preparation and analysis of given sample • Categorizes different preparatory, separation and analytical techniques • Recognizes the applications of various techniques in biology	Suggested Pedagogical Processes- • Undertake problem solving activity • Demonstrate use of instruments • Conduct visits to the instrumentation facility • Hands on training on use of techniques. • Use power point presentations describing the functioning of certain techniques

Unit No.	Title of Unit and Contents
1	**Making solutions** 1.1 SI System of measurement: Fundamental and derived units. 1.2 Moles and molarity, stock solutions and dilutions, making media and reaction mixtures 1.3 pH measurements and preparation of buffers
2	**Microscopy and microscopic techniques** 2.1 Sample preparation for different microscopy techniques. 2.2 Light, phase contrast, fluorescence, electron, confocal microscopy. 2.3 Micrometry. 2.4 Flow cytometry.
3	**Chromatographic techniques** Paper, thin layer and column chromatography, gel filtration, ion exchange and affinity chromatography, HPLC,GC
4	**Electrophoretic techniques** electrophoresis under native, dissociating and denaturing conditions, isoelectric focusing, staining, 2-D electrophoresis
5	**Radioactive techniques** 5.1 Isotopes and their half-life, Specific activity of radioisotopes, making radioisotope solutions 5.2 Detection and measurement of radioactivity - counters 5.3 Autoradiography
6	**Spectroscopic techniques** 6.1 UV -Visible, IR spectroscopy, spectrofluorimetry, NMR and ESR spectroscopy, circular dichroism spectroscopy,AAS. 6.2 Spectrometric techniques: mass spectrometry, MALDI-TOF
7	**Electrochemical techniques** 7.1 Construction and working of equipment for measurement of electrical conductivity 7.2 Construction and working of equipment for measurement of pH meter.
8	**Centrifugation techniques** 8.1 High speed centrifuges, rotors, ultracentrifugation 8.2 Density gradient centrifugation.

9	**Gas exchange measurements** Infra red gas analyzer, O_2 electrode
10	**Immunological techniques** Antibodies and their specificity, antigen-antibody interactions, Immunodiffusion, Immunoprecipitation and Immunoelectrophoresis techniques, RIA, ELISA, Immunofluorescence.
11	**Methods in field biology** 11.1 Ground and remote sensing 11.2 Use of GIS, GPS, Satellite imaging

Learning Resources:

1. P. Gunadegaram (1995). Laboratory Manual in Microbiology. New Age International (P) Ltd.
2. Srivastava M.L. (2008). Bioanylatical Techniques. Narosa Publishing House (P) Ltd.
3. Gamborg O.L., Philips G.C. (Eds.) (1995). Plant Cell, Tissue and Organ Culture Fundamental Methods. Narosa Publishing House (P) Ltd.
4. Krishnamurthy K.V. (1999). Methods in Cell Wall Cytochemistry. CRC Press. LLC.
5. Plummer David (1987). An Introduction to Practical Biochemistry. 3rd Eds. Tata McGraw-Hill Publishing Company Ltd.
6. Sadasivam S.,Manickam A. (1996). Biochemical Methods. 2nd Edn. New Age International (P) Ltd.
7. Khasim S.M. (2002). Botanical Microtechniques: Principles and Practice. Capital Publishing Company.
8. Harborne J.B. (1998). Phytochemical Methods. Springer (I) Pvt. Ltd.
9. Wilson K., Walker J. (2005). Principles and Techniques in Biochemistry and Molecular Biology. Cambridge University Press.
10. Wilson K., Walker J. (2000). Practical Biochemistry Principles and Techniques. Cambridge University Press.
11. Egerton R.F. Physical Principle of Electron Microscopy: an Introduction to TEM, SEM and AEM.
12. Bisen P.S. Mathur S. (2006). Life Science in Tools and Techniques. CBS Publishers, Delhi.
13. Marimuthu R. (2008). Microscopy and Microtechnique. MJP Publishers,Chennai.
14. Sharma V.K. (1991). Techniques in Microscopy and Cell Biology. Tata McGraw-Hill Publishing Company Ltd.
15. Prasad and Prasad (1984). Outline of Microtechnique. Emkay Publications, Delhi.
16. Srivastava S. and Singhal V. (1995). Laboratory Methods in Microbiology. Anmol Publication Pvt. Ltd. Delhi.
17. Annie and Arumugam (2000). Biochemistry and Biophysics, Saras Publishing, Tamilnadu.
18. Sass John E. (1984). Botanical Microtechniques. Tata McGraw-Hill Publishing Company Ltd.
19. Pal and Ghaskadabi (2009). Fundamentals of Molecular Biology. Oxford Publishing Co.

BOT4206 Botany Practical - III

Credits: 4

(20P of 3Hrs)

Course Outcomes
The learner,

- Understands the diversity in habits of Pteridophytes and Gymnosperms
- Examines the specimens and classifies them in different groups
- Describes the variation in reproductive structures of plants
- Recognizes the specimen, collects it from nature, treats and preserves it with appropriate method
- Identifies and classifies the specimens upto genus level
- Develops sectioning, staining and mounting technique

Practicals based on Pteridophytes- 2C (Any 10P of 3Hr)

Pract. No.	Title
	Morphological and/or anatomical and/or reproductive studies of the following members with the help of live material/or herbarium specimens and/or museum specimens and/or permanent slides of the following orders: (any 8 orders)
1	Psilotales,
2	Lycopodiales,
3	Selaginellales,
4	Isoetales,
5	Equisetales,
6	Ophioglosales,
7	Osmundales,
8	Filicales,
9	Salviniales
10	Study of available fossils of Pteridophytes
11	Excursion tour for collection of plants and preparation of report (At least 5 days)
12	Digital herbarium preparation
13	Study of antimicrobial activity of pteridophytes

Practicals based on Gymnosperms- 2C (Any 10P of 3Hr)

1	Study of available fossils of gymnosperms
	Morphological and / or anatomical and/or reproductive studies of the following members with the help of live material / or herbarium specimens and / or museum specimens and / or permanent slides of the following orders:
2	Cycadales,
3	Coniferales- *Pinus, Cupressus,*
4	Coniferales- *Podocarpus, Juniper,*
5	Coniferales-*Araucaria, Agathis*
6	Gnetales
7	Case study of specific genera of coniferales
8	Case study of specific genera of cycadales, gnetales, ginkgoales
9	Wood anatomy of conifers
10	Excursion tour for collection of plants and preparation of report (At least 5 days)
11	Digital herbarium preparation

BOT4207 Botany Practical - IV

The learner,

- Applies differential centrifugation technique to isolate various cell organelles and evaluates their properties with different methods
- Interpretes the structural properties of cell organelles with the help of electron micrographs
- Discriminates the cell types with the help of cytochemical techniques
- Demonstrates the technique of DNA isolation
- Carries out DNA and protein gel electrophoresis technique
- Concludes the result of electrophoresis and genetic engineering techniques

Practicals based on Cell Biology- 2C (Any 10P of 3Hr)

Practical No.	Title
1	Differential centrifugation for isolation of cell fractions – Nuclear fraction
2 3	Isolation of chloroplasts to study: a. Hill reaction to measure intactness, b.Measurement of size of chloroplasts using micrometry and chlorophyll estimation
4	Isolation of mitochondria for estimation of succinic dehydrogenase activity
5	Isolation of lysosomal fraction and estimation of acid phosphatase activity
6	Study of electron micrographs of cell organelles
7	Study of metaphase nucleus: Localization of euchromatin and heterochromatin.
8	Cytochemical studies of special cell types- guard cells, senescent cells, bundle sheath cells.
9	Cytochemical studies of special cell types- meristematic cells, laticiferous cells, glandular cells, pollen grains.
10	Study of induced cell senescence in leaf discs
11	Micrometry to study different cell sizes: Plant cells, Fungal cells
12	Ouchterlony immunodiffusion technique to study specificity of Antigen-Antibody
13	Study of programmed cell death in plants

Practicals based on Molecular Biology and Genetic Engineering- 2C (Any 10P of 3Hr)

1	Isolation of plasmid DNA
2	Isolation of plant genomic DNA
3	Quantification of DNA
4	Electrophoretic separation of plasmid isoforms
5	Restriction digestion of plasmid DNA
6	Gel electrophoresis of digested products and molecular weight determination of DNA fragments.
7	Effect of temperature and alkali on absorbance of DNA – hyperchromicity
8 9	Isolation of proteins from plant material Quantification of proteins
10 11	SDS-PAGE separation of proteins Gel casting & Electrophoresis Visualization of results