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	Plant Systematics & Developmental Botany	Special-1	04
	BOT5302	Plant Biotechnology	Special-2	04
	BOT5303	Plant Ecology **OR**	D Elect-2	04
	BOT5304	Environmental Law (MOOCS)	M Elect-2	04
	BOT5305	Industrial Botany **OR**	D Elect-3	04
	BOT5306	Biomolecules: Structure, function in health and disease (MOOCS)	M Elect-3	04
	BOT5307	Botany Practical V	P Special-1	04
	BOT5308	Botany Practical VI	P Special-2	04
IV	BOT5401	Biostatistics and Bioinformatics **OR**	D Elect-4	04
	BOT5402	Biostatistics (MOOCS)	M Elect-4	04
	BOT5403	Summer Training And Research Project	P Special-3	08

Program Outcomes (POs) for M. Sc. Programm	
PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that form a part of an postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	**Research-related skills and Scientific temper:** Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge**: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence**: Performing independently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics**: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability**: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs) for M. Sc. Botany	
PSO1	**Academic competence** (i) Recall fundamental concepts, state principles and outline processes underlying in the field of Botany, its different subfields and its linkage with related disciplinary areas/subjects. (ii) Demonstrate an understanding of a wide range of physiological, biochemical, cellular, molecular, developmental processes in plant cell. (iii) Execute botanical excursion tour for correct taxonomic identification, collection, preservation of plant specimens.
PSO2	**Personal and Professional Competence** (i) Carry out activities effectively as an individual or a member of a team or leader of a group to fulfil the responsibilities related to group activities. (ii) Analyse data and samples procured during experiments, projects, and field work. (iii) Formulate the ideas, draft scientific reports, authenticate conclusions, present effectively with effective communication skills. (iv) Implement self-learning, discipline, and take logical correct approach for solving problems.
PSO3	**Research Competence** (i) Apply appropriate techniques to solve and analyse problems with specific reference to biological techniques and instrumentations. (ii) Integrate knowledge of fundamental aspects of Botany with applied aspects to design the experiment, interpret the data, and provide valid conclusions. (iii) Assess problems, identify, formulate research literature, and test probable solutions for challenges in various fields of Botany.
PSO4	**Entrepreneurial and Social competence** (i) Employ the applied knowledge of Botany for self-employment with demonstration of true values of leadership, co-operation, and teamwork. (ii) Associate the impact of anthropogenic factors, importance of conservation, diversity, and our social role in sustainable development. (iii) Execute social competence including listening, speaking, observational, effective interactive skills and presenting skills to meet global competencies.

Course Outcome (COs)		
F.Y. M.Sc. Semester I		
Title of the Course and Course Code	**Fundamental Botany I (BOT4101)**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Outline the position of algae, fungi and bryophytes in latest classification system. List the morphological and anatomical characters of the group and give examples of each group.	
CO2	Classify the groups and differentiate the taxonomic forms. Exemplify endosymbiotic and symbiotic associations of lower groups. Implement bioprospecting of fungi.	
CO3	Interpret the life cycle strategies of various groups and illustrates them.	
CO4	Categorize the lower plants and discriminate the groups from each other using salient features. Identify economic importance of the members of the lower groups.	
CO5	Compare the orders with respect to range thallus organization, morphological and anatomical characters, pigmentation, reserved food reproductive structures and life cycle patterns and interrelate them.	
CO6	Arrange various taxonomic groups as per their evolutionary features.	

Unit No.	Title of Unit and Contents
I	**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
II	**Diversity of Algae I** 2.1 Chlorophyta: structure and evolution of thallus, life cycle patterns, reproduction 2.2 Charophyta and Euglenophyta: structure and reproduction
III	**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.

IV	**Commercial products prepared from algae**
V	**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
VI	**Symbiotic Fungal Associations** 6.1 Lichen: types, morphology, reproduction and uses. 6.2 Arbuscular mycorrhizal fungi: diversity and abundance. 6.3 Endophytic fungi
VII	**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
VIII	**Bioprospecting of Fungi**
IX	**Introduction to Bryophytes** 9.1 Morphological characters used for classification 9.2 Systems of classification of Bryophytes (Stotler & Stotler,2005) (Schimp)
X	**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.
XI	**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.

Title of the Course and Course Code	Plant Physiology and Biochemistry (BOT4102)	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Identify the role of various enzymes and their importance in metabolic pathways.	
CO2	Interprete the role of light in various developmental processes and effect of stress on plants. Represent the mechanism of conduction and transport of water and minerals	
CO3	Illustrate the roles of PGR's and secondary metabolites in plant growth and defence.	
CO4	Order the different steps in important metabolic pathways like nitrogen metabolism and water transport.	
CO5	Compare the structure, biosynthetic & metabolic pathways of primary metabolites, secondary metabolites and plant growth regulators.	
CO6	Integrate the metabolic processes like photosynthesis and respiration and propose their dependence.	

Unit No.	Title of Unit and Contents
I	**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
II	**Photosynthesis** 2.1 Photosynthetic pigments, absorption and transformation of radiant energy, Light harvesting complexes, 2.2 Kok curve, Kautsky curve, ETS, photo inhibition O2 and H2 evolution, regulation of Calvin cycle, RUBISCO activity, Photorespiration, 2.3 CAM, C4 Pathway and its types 2.4 Reduction of carbon dioxide - RuBPcase and Calvin cycle, CO2 concentrating mechanisms in C4 and CAM plants.
III	**Respiration** 3.1 Glycolysis, Kreb's Cycle, pentose phosphate pathway 3.2 Organization of mitochondrial electron transport system, ATP synthesis, respiratory control, anaerobic respiration.
IV	**Transport of water and minerals** 4.1 Properties of water and pH. 4.2 Water uptake, transport and transpiration, stomatal physiology 4.3 Mineral nutrition of plants, Ion transport - passive and active

V	**Nitrogen metabolism** 5.1 Uptake and assimilation of nitrogen 5.2 Enzymes involved 5.3 Biological nitrogen fixation
VI	**Enzymology** 6.1 Classification and properties of enzymes 6.2 Oupled reactions, units of enzyme activity 6.3 Enzyme kinetics 6.4 Inhibitors, enzyme regulation.
VII	**Plant growth regulators** Structure, biosynthesis, metabolism and physiological role of auxins, cytokinins, gibberellins, abscissic acid and ethylene.
VIII	**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.
IX	**Secondary metabolites** 9.1 Major secondary metabolite synthesis pathways in plants (Alkaloids, Terpenoids and Phenolics). 9.2 Role of secondary metabolites with their applications
X	**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.

Title of the Course and Course Code	Genetics & Evolution (BOT4103)	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Recall basic concepts of Genetics, state laws of inheritance, identify examples of cytoplasmic and quantitative inheritance.	
CO2	Predict gene interactions and translate the result into Neo-Mendelian ratios. Categorize mechanisms of evolution and allied concepts	
CO3	Interpret the results of linkage and recombination and construct gene maps. Solve the problems on population genetics, gene interactions. Explain concepts of microbial genetics and illustrate the pathways regarding bacteriophages.	
CO4	Distinguish between structural alterations of chromosomes and analyse them.	
CO5	Compare the traditional evolution theories and integrate them using modern molecular evolution theories.	
CO6	Arrange the events of the geological time scale to understand the phenomenon of evolution. Assemble the steps of origin of cell and metabolic processes to bring out the full picture of evolution.	

Unit No.	Title of Unit and Contents
I	**Principles of Mendelian inheritance** 1.1 Early concepts of inheritance, discussions on Mendel's paper 1.2 Gene interactions.
II	**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)
III	**Quantitative inheritance and Inheritance of complex traits** Inheritance of quantitative traits and complex traits, heritability and its measurement
IV	**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.
V	**Recombination, Linkage and mapping of eukaryotes** 5.1 Concept of gene, allele, multiple alleles, pseudo allele-complementation tests

	5.2 Linkage and crossing over, Recombination, inducing transposition 5.3 Linkage maps, lod score for linkage testing 5.3 Mapping by 3-point test cross, Mapping by tetrad analysis in Yeast (unordered) and Neurospora (ordered)
VI	**Mutation** 6.1 Causes, detection and types. 6.2 Insertional mutagenesis, Point mutagenesis.
VII	**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.
VIII	**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
IX	**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
X	**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
XI	**Molecular Evolution** Concepts of natural evolution, origin of new genes and proteins, gene duplication and divergence
XII	**The mechanism of evolution** Isolation mechanism, speciation, allopatry and sympatry, parapetry, convergent evolution, sexual selection, co-evolution

References:

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.
   Burnham, C.R (1962). Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.

4. 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.

Title of the Course and Course Code	Botany Practical I (BOT4104) Any 10 to 15 practicals of 3Hrs	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Identify and name the specimens of algae, fungi and bryophytes with vegetative and reproductive parts. Clarify the position of lichens and outline its internal and external structure	
CO2	Explain thallus range using fresh and preserved plant materials and discuss the industrial applications of the groups. Estimate citric acid by titration and interpolate the result	
CO3	Examine the vegetative and reproductive structures and predict the position of specimens in classification.	
CO4	Compare the groups to find the interrelations and discriminate them from each other. Identify and isolate soil fungi including mycorrhiza.	
CO5	Justify the position of specific specimens in particular divisions and support the explanation. Validate antibacterial activity of bryophytes.	
CO6	Generate inventory of the specimens by exploring a given area, write a report and collect the representative specimens of the key groups. Perform herbarium preparation and alginate production method, produce results of Spirulina culture and construct growth curve of algae	

Practicals based on Algae (Any 5 to 7P of 3Hrs) -

Practical No.	Title
	Morphological observations, documentation (description and illustrations) and classification 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 5 to 7P of 3Hrs)-

1	Study of Lichens
2 **3** **4** **5** **6** **7**	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): Myxomycotina, Mastigomycotina, Zygomycotina, Deuteromycotina, Ascomycotina, 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 2 to 3P of 3 Hrs)-

1 **2** **3** **4**	Study of representative genera belonging to: Marchantiales- *Riccia, Cyathodium, Marchantia,* Marchantiales- *Plagiochasma, Targionia, Astrella.* Anthocerotales Funeriales
2	Study of antibacterial activity of bryophytes

Title of the Course and Course Code	**Botany Practical II (BOT4105)**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Prepare solutions with appropriate concentrations. Identify different stages of mitosis and meiosis.	
CO2	Estimate the enzyme activities and compare the effect of different factors on enzyme activities. Categorize different fossil types by studying the characters.	
CO3	Use proper method for analysis of biochemical contents of different plant parts. Execute the method to carry out steps to demonstrate mitosis, meiosis and polyploidy.	
CO4	Deconstruct the different concepts of genetics and solve problems based on them.	
CO5	Assess the results of experiments, calculate the results of experiments and interpret it with the help of graphs. Discriminate the organisms on the basis of sexual dimorphism.	

CO6	Plan and perform the experiments, compile the observations, draw conclusions and propose the result.

Practicals based on Plant physiology and biochemistry- 2C (Any 5 to 7P 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 5 to 7P of 3Hrs)

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

F.Y. M.Sc. Semester II		
Title of the Course and Course Code	**Fundamental Botany II (BOT4201)**	**Number of Credits : 04**
Course Outcome (CO) **On completion of the course, the students will be able to:**		
CO1	Outline the position of Pteridophytes and Gymnosperms in latest classification.	
CO2	Classify the specimens and associate them with salient features, distribution, morphology, anatomy and reproductive structures of their respective orders.	
CO3	Examine the morphological and anatomical characters of the specimens and illustrate the life cycle strategies. Interpret evolution of pteridophytes and Gymnosperms.	
CO4	Discriminate primary and evolved characters of various orders and relate the orders with each other. Identify economic importance of Pteridophytes and Gymnosperms.	
CO5	Compare fossil groups using their distinctive features. organize fossil groups of pteridophytes and gymnosperms in increasing order of complexity of characters.	
CO6	Integrate the data of characters of different groups to design evolutionary development amongst the groups.	

Unit No.	Title of Unit and Contents
I	**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)
II	**Study of pteridophytic fossil groups:** Psilopsida, Lycopsida, Sphenopsida, Pteridosperms
III	**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

IV	**Evolution in Pteridophytes** 4.1 Apogamy, apospory 4.2 Telome theory, stelar and soral evolution, gametophyte evolution, 4.3 Heterospory and seed habit.
V	**Introduction to Gymnosperms** 5.1 Classification system of Gymnosperms (Christenhusz,2011) 5.2 Geographical distribution, characteristic features 5.3 Affinities with pteridophytes and angiosperms.
VI	**Study of gymnospermic fossil groups** Progymnosperms, Pteridospermales, Cycadeoidales, Pentoxylales, Ginkgoales
VII	**Evolution of seed in gymnosperms**
VIII	**Diversity of Gymnosperms** Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology, and interrelationships of - Cycadales**,** Ginkgoales, Welwitschiales, Ephedrales, Gnetales, Pinales, Aurocariales, Cupressales
IX	**Economic importance of pteridophytes & gymnosperms**

References:

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.
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Title of the Course and Course Code	Cell Biology (BOT4202)	Number of Credits : 04
Course Outcome (CO) **On completion of the course, the students will be able to:**		
CO1	Outline the different cellular processes.	
CO2	Compare different cell signalling pathways.	
CO3	Execute the importance of different components of the secretory pathway in correct order.	
CO4	Explain molecular and functional aspects of various processes in cell life cycle, apoptosis, cell senescence.	
CO5	Support the crucial roles of plant specific cell organelles using ultrastructure and biogenetic pathway.	
CO6	Specify the molecular functional aspects of cell organelles.	

Unit No.	Title of Unit and Contents
I	**Introduction** Cell theory and cell structure, Biogenesis of cell organelles
II	**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.
III	**Cell membranes** 3.1 Molecular organization, transport of ions and solutes across membranes 3.2 Chloroplast and mitochondrial membranes.
IV	**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.
V	**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

VI	**Cytoskeleton** 6.1 Composition, organization and role of microtubules, microfilaments, intermediate filaments. 6.2 Flagella- Structure and organization.
VII	**Signal transduction I** 7.1 Types and functions of receptors, second messengers 7.2 Regulation of signalling pathways, cell-cell interactions 7.3 Signalling pathways- Phospholipid signalling, Ca++-calmodulin cascade
VIII	**Signal transduction II** Diversity in protein kinases and phosphatases, Receptor Serine / Threonine kinase
V	**Signal transduction III** 9.1 Specific signalling mechanisms with suitable examples – biotic and abiotic stress, ABA induced stomatal closure 9.2 Nuclear-organelle signalling during plastid development, Ethylene mediated two component system 9.3 Bacterial chemotaxis and quorum sensing
VI	**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.
VII	**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
VIII	**Apoptosis** Role of different genes, cell organelles during apoptosis, genetic control of apoptosis.

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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.
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6. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA

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Title of the Course and Course Code	**Molecular Biology & Genetic Engineering (BOT4203)**	**Number of Credits : 04**
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Describe structural details of nucleic acids and their properties.	
CO2	Articulate the importance of different molecules for molecular processes.	
CO3	Illustrate the molecular processes from synthesis of molecules to their breakdown.	
CO4	Identify the different levels of gene regulation.	
CO5	Determine use of different genetic engineering tools for better understanding molecular biology.	
CO6	Compile basic molecular processes of prokaryotes and eukaryotes.	

Unit No.	Title of Unit and Contents
I	**DNA-RNA structure and properties** 1.1 Types of base pairing, unusual structures 1.2 Physical, chemical, thermal, spectroscopic properties 1.3 Reassociation kinetics
II	**Packaging of genomes** Packing genomes in viruses, bacteria, organelles and nuclei.
III	**DNA replication** 3.1 DNA replication in prokaryotes 3.2 DNA replication in eukaryotes
IV	**DNA Damage and Repair**
V	**Transcription** 5.1 Organization of gene 5.2 Transcription in prokaryotes 5.3 Transcription in eukaryotes
VI	**RNA Processing** 6.1 Processing of tRNA and rRNA 6.2 Processing of mRNA
VII	**Transcriptional gene regulation** 7.1 Operons 7.2 Phage strategies
VIII	**Protein synthesis** 8.1 tRNA charging, ribosomal organization 8.2 Protein synthesis in prokaryotes

	8.3 Protein synthesis in eukaryotes.
IX	**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.
X	**Protein targeting** 10.1 Targeting of organelle and secretory proteins. 10.2 Localisation of membrane proteins
XI	**Introduction to recombinant DNA technology** 11.1 Steps in rDNA technology 11.2 Enzymes used in genetic engineering
XII	**Vectors** Plasmids, Phages, Cosmids, Phagemids, BACs and YACs, Shuttle vectors, Expression vectors, Ti based vectors
XIII	**Plant genetic engineering** 13.1 Gene transfer methods 13.2 Factors affecting transformation, Screening for transformants, Handling transformants in subsequent generations

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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.

Title of the Course and Course Code	Techniques in Biology (BOT4204)	Number of Credits : 04
Course Outcome (COs) **On completion of the course, the students will be able to:**		
CO1	Name the chemicals used in a particular technique and their role	
CO2	Discuss the principles of different techniques.	
CO3	Generalize applications of different techniques.	
CO4	Analyse different preparatory, separation and analytical techniques with the help of diagrams, construction and use of the parts.	
CO5	Explain the role of various techniques.	
CO6	Specify the proper technique for preparation and analysis of given sample.	

Unit No.	Title of Unit and Contents
I	**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
II	**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.
III	**Chromatographic techniques** Paper, thin layer and column chromatography, gel filtration, ion exchange and affinity chromatography, HPLC, GC
IV	**Electrophoretic techniques** electrophoresis under native, dissociating and denaturing conditions, isoelectric focusing, staining, 2-D electrophoresis
V	**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

VI	**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
VII	**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.
VIII	**Centrifugation techniques** 8.1 High speed centrifuges, rotors, ultracentrifugation 8.2 Density gradient centrifugation.
IX	**Gas exchange measurements** Infra-red gas analyzer, O2 electrode
X	**Immunological techniques** Antibodies and their specificity, antigen-antibody interactions, Immunodiffusion, Immunoprecipitation and Immunoelectrophoresis techniques, RIA, ELISA, Immunofluorescence.
XI	**Methods in field biology** 11.1 Ground and remote sensing 11.2 Use of GIS, GPS, Satellite imaging

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2. Srivastava M.L. (2008). Bioanylatical Techniques. Narosa Publishing House (P) Ltd.
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19. Pal and Ghaskadabi (2009). Fundamentals of Molecular Biology. Oxford Publishing Co.

Title of the Course and Course Code	**Botany Practical III (BOT4206)** **(Any 10 to 15P of 3Hr)**	**Number of Credits : 04**
Course Outcome (CO) **On completion of the course, the students will be able to:**		
CO1	Identify and name the specimens of pteridophytes and gymnosperms with the help of vegetative and reproductive parts.	
CO2	Explain the plant body with the help of anatomy and vegetative and reproductive structures. Discuss the fossil characters and justify the positions of fossils in the relevant orders.	
CO3	Classify the preserved and live specimens and organize them in different orders.	
CO4	Compare the living specimens of different orders and relate them to each other.	
CO5	Section the specimens and discriminate the wood anatomy characters of Gymnosperms.	
CO6	Write a tour report, collect the specimens and organize the herbarium sheets in the order of evolution.	

Practicals based on Pteridophytes- 2C (Any 5 to 7P of 3Hrs)

Pract. No.	**Title**
1 **2** **3** **4** **5** **6** **7** **8** **9**	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) Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales, Ophioglosales, Osmundales, Filicales, 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 5 to 7P of 3Hrs)

1	Study of available fossils of gymnosperms
2 **3** **4** **5** **6** **7** **8**	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: Cycadales, Coniferales- *Pinus, Cupressus,* Coniferales- *Podocarpus, Juniper,* Coniferales-*Araucaria, Agathis* Gnetales Case study of specific genera of coniferales 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

Title of the Course and Course Code	**Botany Practical IV (BOT4207)** **(Any 10 to 15P of 3Hr)**	**Number of Credits : 04**
Course Outcome (CO) **On completion of the course, the students will be able to:**		
CO1	Describe DNA and protein gel electrophoresis technique.	
CO2	Interpret the structural properties of cell organelles with the help of electron micrographs.	
CO3	Apply differential centrifugation technique to isolate various cell organelles and evaluate their properties with different methods.	
CO4	Discriminate the cell types with the help of cytochemical techniques.	
CO5	Assess the result of electrophoresis and genetic engineering techniques.	
CO6	Plan and perform the experiments, compile the observations, draw conclusions and interpret the result.	

Practicals based on Cell Biology- 2C (Any 5 to 7P of 3Hrs)

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 5 to 7P of 3Hrs)

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	Isolation of proteins from plant material
9	Quantification of proteins
10	SDS-PAGE separation of proteins Gel casting & Electrophoresis
11	Visualization of results