CHAUDHARY RANBIR SINGH UNIVERSITY, JIND

DEPARTMENT OF BOTANY

M.Sc. BOTANY Scheme of Examination (CBCS) w.e.f 2022-23

Semester I

Paper code	Title of paper	Type of paper	Hours /week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-101	Algae & Fungi	Core	4	4	80 + 20	100	3 hrs
BOT-102	Bryophytes & Pteridophytes	Core	4	4	80 + 20	100	3 hrs
BOT-103	Cytogenetics & plant breeding	Core	4	4	80 + 20	100	3hrs
BOT-104	Ecology	Core	4	4	80 + 20	100	3 hrs
BOT-105	Practical based on 101 + 102	Core	8	4	80 + 20	100	6 hrs
BOT-106	Practical based on 103 + 104	Core	8	4	80 + 20	100	6 hrs
Total				24		600	

Semester-II

Paper code	Title of paper	Type of paper	Hours/ week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-201	Microbiology and Biostatistics	Core	4	4	80 + 20	100	3 hrs
BOT-202	Natural Resources & Biodiversity	Core	4	4	80 + 20	100	3 hrs
BOT-203	Gymnosperms & Ethnobotany	Core	4	4	80 + 20	100	3 hrs
BOT-204	Molecular genetics	Core	4	4	80 + 20	100	3 hrs
BOT-205	Seminar	Core	1	1	25	25	1 hr
OE	*Open Elective Paper	Open Elective	4	4	80 + 20	100	3 hrs
BOT-207	Practical based on 201 + 202	Core	8	4	80 + 20	100	6 hrs
BOT-208	Practical based on 203 + 204	Core	8	4	80 + 20	100	6 hrs
Total				29		725	

Semester – III

Paper code	Title of paper	Type of paper	Hours /week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-301	Plant physiology & Plant biochemistry	Core	4	4	80 + 20	100	3 hrs
BOT-302	Plant Taxonomy & Economic botany	Core	4	4	80 + 20	100	3 hrs
BOT-303	Plant Biotechnology & Genetic engineering	Core	4	4	80 + 20	100	3 hrs
BOT-304	a) Advanced Phycology-I (elective) b) Applied Mycology (elective) } c) Restoration Ecology (elective) d) Advanced Plant Physiology (elective) e) Biophysical & biochemical techniques (elective)	Elective	4	4	80 + 20	100	3 hrs
BOT-305	Seminar	Core	1	1	25	25	1 hr
OE	*Open Elective Paper	Open Elective	4	4	80 + 20	100	3 hrs
BOT-307	Practical based on 301	Core	6	3	60 + 15	75	6 hrs
BOT-308	Practical based on 302 + 303	Core	6	3	60 + 15	75	6 hrs
BOT-309	Practical based on 304	Core	4	2	40 + 10	50	6 hrs
Total				29		725	

Semester- IV

Paper code	Title of paper	Type of paper	Hours/ week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-401	Physiology of Plant growth & development	Core	4	4	80 + 20	100	3 hrs
BOT-402	Biology of Reproduction and Anatomy	Core	4	4	80 + 20	100	3 hrs
BOT-403	Plant Tissue Culture	Core	4	4	80 + 20	100	3 hrs
BOT-404	a) Advanced Phycology-II (elective) } b) Principles of Plant Pathology (elective) c) Conservation Biology (elective) } 65 + 15 80 d)Plant Growth Regulators (elective) } e) Genomics (elective)	Elective	4	4	80 + 20	100	3 hrs
BOT-405	Practical based on 401	Core	6	3	60 + 15	75	6 hrs
BOT-406	Practical based on 402 + 403	Core	6	3	60 + 15	75	6 hrs
BOT-407	Practical based on 404	Core	4	2	40 + 10	50	6 hrs
Total				24		600	

***To be choosen from the Bucket of CRSU,Jind.**

Total Credits = 106

Total Marks = 2650

Programme Outcomes for PG courses of Faculty of Life Sciences:

1. To acquaint students with recent knowledge and techniques in basic and applied biological sciences.
2. To develop understanding of organismal, cellular, biochemical and environmental basis of life
3. To provide insight into ethical implications of biological research for environmental protection and good laboratory practices and biosafety.
4. To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.
5. To understand the applications of biotic material in health, medicine and food security for human well being and sustainable development.
6. To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self reliance.

Program Specific Outcomes (PSOs):

1. Biodiversity of lower and higher plants along with their taxonomic status. The students will have in-depth knowledge about physiology and metabolism of plants.
2. Students will be able to gain in-depth knowledge regarding ethnobotany, conservation status and strategies of economically important plants.
3. This program aims to critically engage students with concepts of ecological principles, biodiversity, population, community, ecosystem structure and function, importance of environment and the problems related with it at local and global level.
4. The students will have strong base knowledge of physiological, cellular and molecular aspects of plants biology. It will help them venture into advanced research areas.
5. This program will help students to be aware of good laboratory practices in microbial technology and plant biotechnology.

Paper – BOT-101
Algae & Fungi

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: To educate and train the students for professional and research careers in the field of Algology & Mycology.

Course Outcomes:

CO1 The students will be inspired to become aware and comprehend the broader aspects of algae and fungi.
CO2 The learning outcome will be aimed toward advanced academic education to broaden the knowledge of the biodiversity, ecological significance and economic importance of algae.
CO3 The students will be inspired to become well versed with the fungal world in terms of recent research.
CO4 Economic importance of Fungi with regards to its deleterious and beneficial aspects. Modern economic importance of Lichens. Working knowledge of biological laboratories and research centers in India.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Criteria for algal classification (pigments, reserve food, flagella, etc.) and their taxonomic importance.
2. Comparative account of important systems of classification and recent trends.
3. Thallus organization, reproduction and life cycles in algae.
4. Economic importance of algae as food, feed, uses in industries, etc and algal biofertilizers.

Unit-II

5. Biodiversity of algae in different habitats (terrestrial, freshwater, marine, thermal, psychrophilic, subaerial, symbiotic, parasitic, epiphytic, halophytic. etc),
6. Dynamics and consequences of algal blooms and red tides. Algae as major components of phytoplankton. Control of Algal nuisance
7. Morphological features, reproduction and life cycle patterns of the followings:
   Cyanophyta: *Nostoc*, Nitrogen fixation, heterocyst, range of thallus
   Chlorophyta: Range of thallus, *Vaucheria,* and *Chara*
   Xanthophyta: *Botrydium*
   Bacillariophyta: Thallus structure, and reproduction
   Phaeophyta: *Ectocarpus,* and *Sargassum*
   Rhodophyta*: Batrachopsermum, Polysiphonia*

Unit- III

8. General characters of fungi: Thallus organization, nutrition, different kinds of spores and their dispersal and reproduction.
9. Classification of fungi by Ainsworth (1973), Alexopoulos *et. al* (1996), Hawksworth *et al.* (1995).
10. General account and life cycle of the followings:
    Dictyosteliomycota and Myxomycota: *Physarum*
    Chytridiomycota and Oomycota: *Phytophthora* and downy mildews
    Zygomycota: *Rhizopus*
    Ascomycota: *Taphrina,* powdery mildew
    Basidiomycota: *Agracius, Puccinia, Ustilago,*
    Deuteromycota: Sporulating structures, *Fusarium, Alternaria*
11. Concept of Homothallism, Heterothallism, and parasexual cycle.

Unit – IV

12. Economic importance of fungi in nutrient cycling, decomposition, humus formation, decay and deterioration of wood & timber.
13. Causal organisms, symptoms, and management of: Late and early blight of potato, downy mildew of grapes, powdery mildew of peas, green ear disease of Bajra, apple scab, wilt of pigeon pea, karnal bunt of wheat, loose smut of wheat, black, yellow and brown rust of wheat, tikka disease of groundnut
14. Lichens: structure, reproduction, and economic importance

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* Daya Publishing House, New Delhi. 2003.
2. Carr, N.G. & Whitton, B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
3. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publishers.
4.Alexopoulos.C.J. Mims, C.W. and Blackwell, M. 1995: Introductory Mycology, John Willey and Sons. Inc
5.Mehrotra.R.S. and Aneja, K.R.1990 An Introduction of Mycology, New Age International Press, New Delhi.
6.Sumbali. G.2005. The Fungi, Narosa Publ.House, New Delhi
7. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
8. Gupta, R.K. & Pandey, V.D. 2007: Advances in Applied Phycology, Daya Publishing House, Daryaganj, New Delhi.
9. Hoek, C. Van Den, Mann, D.G. & Jahns, H.M. 1995: Algae: An Introduction to Phycology, Cambridge University Press, U.K.
10. Morris, I. 1967: An Introduction to the Algae. Hutchinson & Co (Publ) Ltd. London

Paper–BOT-102
BRYOPHYTES & PTERIDOPHYTES

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The course has been conceived to equip students with the knowledge of characteristics, structure and development of gametophyte and sporophyte in bryophytes & pteridophytes.

Course Outcomes:

CO1 Classify and distinguish bryophytes and pteridophytes from other groups of plants.
CO2 Learn about the origin and evolution of sporophyte, heterospory, origin of seed habit, evolutionary trends in stele and spore producing organs.
CO3 Describe the ecological, economic significance of bryophytes and pteridophytes,
CO4 Appreciate role of these group of plants in understanding basic concepts of morphogenesis, apogamy, apospory and regulation of development *in vitro*.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. General characteristics features of Bryophytes. Classification of Bryophytes upto classes, General account of structure and development of gametophyte, sporophyte of Marchantiales, Jungermanniales and Anthcerotales.
2. General account of structure and development of gametophyte and sporophyte of Sphagnales, Funariales and Polytrichales.

Unit -II

3. Regulation of protonemal differentiation and bud formation.
4. Biology of reproduction- *In Vitro* regulation of gametangia formation: effect of physical and chemical factors, Cytology of Bryophytes, Apogamy and Apospory.
5. Ecological importance of bryophytes: Bryophytes as indicators of pollution and minerals; role of Bryophytes in succession

Unit-III

6. General characteristics of Pteridophytes and their classification
7. Comparative morphology and reproduction of the following:
   Psilophytales (Rhynia, Zosterophyllum), Psilotales (Psilotum), Lycopodiales (Lycopodium, Selaginella), Lepidodendrales (Lepidodendron),
   Sphenophyllales (Equisetum)

Unit- IV

8. Comparative morphology and reproduction of the following :
   Ophioglossales (Ophioglossum, Botrychium), Marattiales (Marattia, Angiopteris),
   Osmundales, Filicales (Pteris, Dryopteris),Marsileales and Salviniales
9. Economic and Ecological significance of Pteridophyte in succession.

Suggested Readings:

1. Parihar, N.S. 1965. An Introduction to Embryophyta Vol. I. Bryohpyta, Central Book Depot, Allahabad, India.
2. Schofield, W.B. 1985. Introduction to Bryology, Macmillan, New York.
3. Chopra, R.N. and Kumra, P.K. 1988. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi.
4. Chopra, R.N. & Bhatla, S.C. 1990. Bryophyte Development: Physiology and Biochemistry.CRC Press, Boca Raton, USA.
5. Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publishing House Pvt. Ltd. New Delhi.
6. Watson, E.V. 1967. The Structure and Life of Bryophytes. B.I. Publications, New Delhi.
7. Glime, J.M and Saxena D. 1991. Uses of Bryophytes. Today and Tomorrow's Printers and Publishers, New Delhi.
8. Richardson, D.H.S. 1981. The Biology of Mosses. Blackwell Scientific Publications, Oxford, London.
9. Parihar, N.S. 1977. The Biology and Morphology of Pteridophytes. Central Book Depot. Allahabad.
10. Rashid, A. 1976. An Introduction to Pteridophyta (Diversity and Differentiation). Vikas Publishing House Pvt. Ltd., New Delhi.
11. Sporne, K.R. 1985 (reprint) The Morphology of Pteridophytes. B.I. Publications Pvt. Ltd., Delhi.

Paper – BOT-103

CYTOGENETICS AND PLANT BREEDING

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The purpose of this paper is to acquaint the students about structure and functions of a chromosome in detail. The course also explains the chromosomal variations and their effects on biological system. Further, it aims to draw attention to methods used for crop improvement.

Course Outcomes:

CO1 The students get acquainted about the different cytogenetic and molecular techniques used for genome analysis.
CO2 This course will enable the students to use linkage and recombination frequencies in gene mapping.
CO3 The students get familiarised about role of chromosomes in sex determination and generation of variations.
CO4 The students will know about the methods that can be used to create the desired genotype/phenotype.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Chromatin structure and organization: Chromosome structure and DNA packaging; euchromatin and heterochromatin.
2. Organization of plastid and mitochondrial genomes.
3. Special Chromosomes: Structure, occurrence and behaviour of polytene, lampbrush, B and sex chromosomes.
4. Karyotype: Karyotype analysis and its evolution; FISH, GISH and flow cytometery.

Unit-II

5. Cell cycle: Cell cycle phases, checkpoints and regulation.
6. Chromosome banding techniques and their applications.
7. Linkage and crossing over: Molecular mechanism of crossing over and role of different enzymes; linkage groups.
8. Chromosome mapping- Two point and three point test crosses.

Unit-III

9. Sex determination: Chromosomal and gene determining sex in plants, animals, *Drosophila* and humans; Gene dosage compensation.
10. Structural alterations in chromosomes – Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.
11. Variation in chromosome number: Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement.

Unit-IV

12. Principles of plant breeding: Principles and objectives; methods of breeding self and cross pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding.
13. Asexual breeding systems: Methods of breeding of vegetatively propagated crops; Non- conventional methods; gene variability.
14. Male sterility: Concept; classification; genetic control; inheritance pattern and breeding utility.

Suggested Readings:

1. Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
2. Gustafron JP (2002) Genomes, Kluwer Academic Plenum Publishers, New York, USA.
3. Karp G (1999) Cell and Molecular Biology, John Wiley and Sons, USA.
4. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
5. Lewin B (2010) Gene X, Jones and Barlett Publishers.
6. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6th Ed), W.H. Freeman and Company, New York, USA.
7. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
8. Poehlman JM and Sleper DA (1995) Breeding Field Crops, AVI. Publ., U.S.A.
9. Russell PJ (2006) Genetics (5th Ed.), Addison Wesley Longman, California, USA.
10. Snustad P and Simmons MJ (2011) Principles of Genetics. (6th Ed.), John Wiley, New York.
11. Weaver RF (2005) Molecular Biology, McGraw Hill International Edition.
12. Watson, JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.

Paper – BOT-104
ECOLOGY

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: Critically engage with concepts of Ecological principles and importance of environment and the problems related with it at global and local level.

Course Outcomes:

CO1 Students will be able to understand about limiting factors controlling distribution and growth of organisms.

CO2 Students will be able to develop insights about the concepts of populations, community and ecosystems and can use in management of natural resources for sustainable development.

CO3 Students will be able to comprehend interactions among components of ecosystems for better stability.

CO4 By understanding the concept of ecological principles and environmental issues, the students will be able to develop attitude, value system and ethics towards environmental related issues.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. The Environment: Physical environment, biotic environment, biotic and abiotic interactions; Tolerance range and limiting factors, ecotypes
2. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
3. Population ecology: Concept, characteristics, population growth and regulation, species interactions—mutualism, competition, allelopathy, predation, parasitism, Life-history strategies and r-and K selection, concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations

Unit-II

4. Community structure and organization; Nature of communities, community structure and its attributes; species diversity, Edges and ecotones, vegetation characteristics (analytical and synthetic characters, methods of analysis.
5. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit-III

6. Ecosystem organization: structure and functions; primary production (global pattern and controlling factors); energy dynamics—trophic levels, energy flow pathways and ecological efficiencies.
7. Decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P, & S, ecosystem stability (resistance and resilience).

Unit-IV

8. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India, speciation and extinction, endemism.
9. Global atmosphere changes: Environmental pollution, global environmental change and its consequences (CO2 fertilization, global warming sea level rise and UV radiation).

Suggested Readings :

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Miller (Jr.) and G. Tyler (1994) : Living in the Environment. Wadsworth Publishing Company, Belmont, California.
3. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
4. Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
5. Ramakrishnan, P.S. 2000. Ecology and Sustainable Development. National Book Trust, India
6. Robert Ricklefs (2001). The Ecology of Nature. Fifth Edition. W.H. Freeman and Company.
7. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
8. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.
9. Steffen, W., A. Sanderson, P. D. Tyson, J. Jager, P. M. Matson, B. Moore, III, F. Oldfield, K. Richardson, H. J. Schnellnhuber, B. L. Turner, II, and R. J. Wasson. 2004. Global change and the Earth system: a Planet under Pressure. Springer-Verlag, New York, New York, USAReference books.
10. Townsend, C.R., Begon, M. And Harper, J.L. 2003. Essentials of Ecology. Second Edition. Blackwell Publishing, Oxford.

Paper – BOT-201
Microbiology and Biostatistics

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives The Course has been conceived to equip the students with the knowledge of various microbial pathogens and their effect on humans affairs. In addition, the course also deals with the growth, collection and maintenance of microbes, their interactions and control of different therapeutic methods.

Course Outcomes:

CO1 To acquaint the students with the knowledge of various microbes (viruses, bacteriophages, and Cyanobacteria their impacts on Biological Importance.

CO2 The Course has been conceived to equip the students with the knowledge of various laboratory conditions for their culture and maintenance of microorganisms in terms of their control through physical and chemical methods.

CO3 It is aimed to impart knowledge about microbial interactions in the wider context of Environmental Microbiology biological laboratories and research centers in India.

CO4 Working knowledge of biostatistics and their importance in the plant sciences while discussing the results & findings in terms of correlations, regressions and other details.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Structure & replication of viruses and bacteriophage; transmission & control of viruses; Isolation & purification of Plant Viruses.
   Diseases caused by Viruses: TMV, Tristeza of citrus
2. Structure, nutrition, reproduction, and economic importance of bacteria.
   Diseases caused by bacteria: Bacterial blight of paddy, Crown gall of stone fruits
   A brief account of Cyanobacteria, and phytoplasmas

Unit-II

3. Growth, culture and maintenance of microorganisms, Microbial growth and measurement, environmental factors influencing growth. Maintenance and preservation of cultures: Subculturing, Storage under mineral oil, Water storage, soil storage, deep freezing, Lyophilization, and Cryogenic storage. Culture collection centers
4. Control of microorganisms: Physical methods (High temperature, dry hot or hot-air sterilization, moist air sterilization, low temperature, filtration, lyophilization, Radiation), Chemical methods (Disinfectants and antiseptics)

Unit-III

5. Microbial interaction: Functions of symbiotic relationships, types of symbiosis, commensalism, synergism, mutualism-(Lichens, Bacterial endosymbionts of protozoa, Nitrogen-fixing symbiosis, mycorrhizae), parasitism.
6. Environmental Microbiology: Microbiology of fresh, marine and extreme environment, Biofilms, Bioremediation of polluted environment, Bioleaching.

Unit-IV

7. Biostatistics: Brief description and tabulation of data and its graphical representation.
8. Measures of central tendency and dispersion.
9. Mean, mode, median, range standard deviation, variance idea of two types of errors and level of significance, tests of significance (F & t test); chi-square test.
10. Simple Linear Regression and Correlation.

Suggested Readings:

1. Gupta R & Mukherji K G (2001). Microbial technology, APH Publ. co., New Delhi.
2. Pelezar, MJ, Chaing, ECS & Krieg, NR (1993). Microbiology, Tata McGraw-Hill Publ. New Delhi.
3. Prescott, LM., Harley, JP & Klein, DA (1996). Microbiology Wm. C. Brown Publ. USA.
4. Ronald, M Atlas (1995). Principles of microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
5. Singh R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.
6. Sumbali, G. 2005: The Fungi, Narosa Publ. House, New Delhi.
7. Statistics for Biologists (1974) Campbell R.C. Cambridge University Press, Cambridge.
8. Statistics in Biology, Vol. 1 (1967) Bliss, C.I.K. McGraw Hill, New York

Paper-BOT-202
Natural Resources and Biodiversity

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: This course aims to develop knowledge regarding natural resources and their utilization. This also aims to critically engage students with biodiversity-its status, monitoring and conservation.
Course Outcomes: After completion of course the students will be able to understand
CO1 Resources and their sustainable uses.
CO2 Environmental issues at global and local level.
CO3 Ecosystem Restoration
CO4 Conservation status and strategies, sustainable indicators

Note:-

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short –answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise with two questions from each unit I, II, III & IV. The candidates will be required to attempt Q. No. 1 and four more selecting one question from each section.

Unit-I

1) Resources: Types, Renewable and non-renewable resources; resources degradation and conservation.
2) Land resources: Land degradation and desertification; management of waste lands in India.
3) Water resources: Pools of water and Hydrological cycles, surface water and ground water; water-use and management.
4) Environmental pollution of air, water and soil-types, sources and effects.

Unit-II

5) Forest resources: Forests and their importance, Non timber forest produce, forest resources of India and forest management.
6) Types of energy resources, renewable sources of energy-wine energy, wave energy, Energy from biomass, bioconversion technologies, energy plantation and petrocrops.
7) Ecosystem restoration and Environment impact assessment- Brief account.

Unit- III

8) Principals of resources conservation and conservation strategies.
9) Biological diversity: importance, concept and levels biodiversity, threats to biodiversity-habitat loss and fragmentation, exotic species, pollution, species extinctions; IUCN categories of threat.
10) Distribution and global patterns of biodiversity.
11) Terrestrial and marine hotspots of biodiversity; Hotspots of biodiversity in India.

Unit- IV

12) *In situ* conservation of biodiversity: Protected area in India wildlife sanctuaries, national parks, biosphere reserves.
13) Conservation of biodiversity of wetlands, mangroves and coral reefs.
14) *Ex situ* biodiversity conservation: principles and practices, field gene banks, seed banks and cryopreservation.
15) Sustainable development: concept, principles and strategies; sustainability indicators.

Suggested Readings:

1. Ball, J.B. 2001. Global forest resources: history and dynamics. In: *Forest Handbook Volume* 1, Evans, J. (ed.) Blackwell Science, Oxford.

2. Chape, S., Fish, L. Fox, P. and Spalding, M. 2003. United Nations list of protected areas. UCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge.
3. Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk by. The Hague.
4. Heywood, V.(Ed.) (1995) Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge.
5. Huston, M.A. 1994. *Biological Diversity*: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
6. Owen, O.S., Chiras, D.D. and Reganold, J.P. 1998. Natural Resource Conservation: Management for Sustainable Future. Seventh Edition. Prentice Hall. Upper Sadle River, New Jersey.
7. Raven, P.H. and Berg, L.R. 2005. Environment , 5th Edition, John Wiley & Sons Inc., New York.
8. Singh, J.S. and Singh, S.P. 1992. *Forests of Himalaya, Structure, Functioning and Impact of Man.* Gyanodaya Prakashan, Nainital, India.
9. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.

Paper – BOT-203
Gymnosperms &Ethnobotany

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: This course is intended to provide the basic understanding of morphology and reproduction in pteridophytes and gymnosperms. It also describes the modern methods of propagation of gymnosperms.

Course Outcomes:

CO1 Classify and distinguish gymnosperms from other groups of plants.
CO2 Trace evolutionary trends in development of male and female gametophytes
CO3 Learn about economic importance of gymnosperms and modern methods of their propagation.
CO4 Explain the ethnobotany, its history, significance , methods and techniques used in ethnobotanical study and research.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Classification of gymnosperms and their distribution in India.
2. Brief account of the following families:
   Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.

Unit – II

3. General account of the following orders:
   Cycadeoidales(Cycadeoidea), Pentoxylales, Cordiatales
4. Comparative account of Structure and reproduction in the following orders:
   Cycadales (Cycas), Ginkgoales (Ginkgo).

Unit- III

5. Coniferales (Pinus, Cedrus), Ephedrales (Ephedra), Welwitschiales, Gnetales
6. Economic importance of gymnosperms, Role of Gymnosperms in Biodiversity.
7. Modern methods of propagation of gymnosperms: somatic embryogenesis, haploids and protoplast culture

Unit-IV

8. Ethnobotany: History and importance of ethnobotany, ethnomedicobotany, ethnozoology, ethnoveterinary, ethnomusicology and ethnoagriculture
9. Wild edible plants used as emergency food by triblals in India, methods and techniques in ethnobotanical study and research.
10. Traditional plants: Cereals, pulses, vegetables, spices and mushrooms, wild edible fruits and seeds. Plants in folk songs and proverbs. Sacred grooves, Impact of moderenization.

Suggested Readings

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
2. Sporne, K.R. 1965. The Morphology of Gymnosperms. B.I. Publications Pvt. Ltd., New Delhi.
3. Bierhorst, D. W. 1971. Morphology of Vascular Plants. Macmillan. New York.
4. Cotton, C.M. 1996. Ethnobotany- Principles and Appliations, Centruy School Book by service Film setting Ltd.
5. Dahlgren. R.H., Clifford, T and P.F Yeo 1985.The families of the monocotyledons; structure, Evolution and Taxonomy. SpingeVerag, NY.
6. Gary J, Martin, 2004. Ethnobotany- A Methods Manual, Chapman and Hall. U.K.
7. Jain S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
8. Jain S.K. 1987. A manual of ethnobotany. Scientific publisher Jodhpur.

9. Jain S.K. and Mundgal, 1999. Handbook of ethnobotany, London.
10. Pursrglove, J.W. 1972. Tropical Crops-Monocotyledons and Dicotyledons of ethnobotany, ethnomedicine, ethnoecology, ethnic communities.
11. Rao, P.C. 2006. Medicinal plants: Ethanobotanical Approach, Agribios, India.
12. Trivedi, P.C. 2006. Medicinal plants: Ethanobotanical Approach, Agribios, India.
13. Yoganarasimhan, S.N. Medicinal Plants of India-Vol-I- Karnataka, Interline Publishing Pvt. Ltd.

Paper – BOT-204
MOLECULAR GENETICS

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: This course is intended to provide the basic understanding of biological processes such as DNA replication, transposition and mutations. A key thrust of this paper is towards the molecular mechanisms involved in the control of gene expression and regulation.

Course Outcomes:

CO1 The students will have enhanced understanding of genome structure, evolution and its replication.
CO2 This course will impart the knowledge of basics of mutations and their importance; DNA repair mechanisms.
CO3 The students will learn about the methods of genetic recombination in bacteria
CO4 The students will gain insight into the principle mechanisms of genome expression and its regulation.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

UNIT-I

1. Eukaryotic genome: Different forms of DNA, C-value paradox, unique and repetitive DNA, gene families, hybridization kinetics and split genes.
2. Transposable elements: Mechanisms of transposition; transposons in bacteria, maize, *Drosophila* and yeast.
3. DNA Replication: Semi-conservative, bidirectional, replication origins, replication machinery.

UNIT-II

4. Mutations: types, isolation of mutants, molecular basis of mutations.
5. DNA damage and repair: Causes of DNA damage; Photoreactivation, excision, mismatch, post replication and error prone repair systems.
6. Fine structure of gene: *cis-trans* test, rII locus, fine structure analysis of eukaryotes.
7. Bacterial genetics: conjugation, transduction and transformation.

UNIT- III

8. Transcription: Initiation, elongation and termination in prokaryotes and eukaryotes, RNA polymerases.
9. RNA Processing: Processing of mRNA, rRNA and tRNA.
10. Genetic code: Deciphering the genetic code, characteristics.
11. Translation: Initiation, elongation and termination in prokaryotes and eukaryotes.

UNIT-IV

12. Regulation of gene expression in prokaryotes: Operon concept, lac operon regulation by positive and negative mechanism, trp operon, regulation by negative and attenuation.
13. Regulation of gene expression in eukaryotes:

a) Transcriptional level – Regulatory sequences, nucleosome positioning, chromatin remodelling, histone modifications.
b) Post-transcriptional level – RNA splicing, RNA stability.
c) Translational level and post-translational level.

Suggested Readings:

1. Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
2. Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Burns GW and Bottino PJ (1989) The Science of Genetics, Macmillan Publishing Co. New York.
4. Clark D (2005) Molecular abiology, Understanding the Genetic Revolution. Elsevier Inc. C. California.
5. Gustafron JP (2002) Genomes.Kluwer Academic Plenum Publishers, New York, USA.
6. Hartl DL (1999) Genetics Principles and analysis. (4th Ed.) Jones and Bartle, Boston.
7. Henry RJ (1997) Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK.
8. Klug WS and Cunning MR (1996) Essentials of Genetics. Prentice Hall London.
9. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
10. Lewin B (2005) Genes VIII. Oxford University Press, New York.

11. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6th Ed), W.H. Freeman and Company, New York, USA.
12. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
13. Russell PJ (2006) Genetics (6th Ed.), Addison Wesley Longman, California, USA.
14 Snustad P and Simmons MJ (2011), Principles of Genetics. (6th Ed.), John Wiley, New York.
15. Swanson CP, Mertz T and Young WJ (1981) Cytogenetics- The Chromosome in Division, Inheritance and Evolution (2nd Ed.), Englewood Cliffs, Prentice Hall, New Jersey.
16. Weaver RF and Hedrick PW (1997). Genetics (3rd Ed.) WMC Brown, Chicago.
17. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.

Paper – BOT-301
Plant Physiology and Plant Biochemistry

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: The course would deal with the study of plant physiology especially the water transport, absorption, mineral nutrition, photosynthesis, respiration and nitrogen metabolism.

Course Outcomes:

CO1 The students will be able to understand the physiology and basic metabolism of plants.

CO2 The students will be learning about the concepts of water potential, transpiration and mechanisms of water absorption in plants.

CO3 During the course students will gain in depth knowledge about mineral nutrition, photosynthesis and respiration in plants.

CO4 The students will be able to increase the understanding about enzymes, lipid metabolism and nitrogen metabolism.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Water: Passive and active absorption of water.
Plant water relations: Concept and components of water potential, soil water relationship, transpiration and factors governing transpiration, antitranspirants.

Unit-II

Mineral Nutrition: Role and mode of action of micro and macro-nutrients.
Photosynthesis: Photo-oxidation of water, cyclic and non-cyclic photophosphorylation, photorespiration and its significance. The sequence of reactions in photosynthesis, the path of carbon assimilation (C3 and C4 cycles, CAM pathway).

Unit-III

Respiration: Glycolysis, Krebs cycle, electron transport chain and ATP synthesis, pentose phosphate pathway, glyoxylate cycle.
Nitrogen Metabolism: Biochemistry of nitrogen fixation, nitrogenase, nitrogen fixation in legumes, nitrate assimilation, ammonium assimilation, biosynthesis of amino acids.

Unit-IV

Lipid Metabolism:
Fatty acid biosynthesis, Alpha and beta-oxidation and conservation into carbohydrates.
Enzymes: Structure, properties and functions of enzymes, factors affecting rates of enzymatic reactions, isozymes, allosteric enzymes.

Suggested Readings:

1. Bonner, J. And Varner, J.E. (1976). Plant Biochemistry, IIIrd Edition, Academic Press, New York and London.
2. Buchanan, B.B., Gruissem, W. And Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
3. Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd
4. Edition. Kluwer Academic Publishers, The Netherlands.
5. Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.
6. Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.
7. Hopkins, W.G. (1995) Introduction to Plant Physiology, John Wiley and Sons.
8. Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
9. Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East-West Press Pvt Ltd. New Delhi.
10. Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India (Indian edition).
11. Lehninger, A.L, Nelson, D.L. and Co MM 1993Principles of Biochemistry Second edition, CBS Publishers.
12. Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi..
13. Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology, Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.
14. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, Wadsworth Publishing Co. Belmont, California, USA.

15. Singhal, G.S. Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (editors) (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
16. Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
17. Taiz, L and Zeiger, E. (1998). Plant Physiology. Second edition. Sinauer Associates, Inc., Publishers, Massachusetts, USA
18. Trehan, K. (1990). Biochemistry. Second edition, Wiley-Eastern Ltd., New Delhi.
19. Trivedi, P.C. (2006). Plant Molecular Physiology: Current Scenario and Future Projections. Aavishkar Publishers, Distributors, Jaipur.
20. Weil, J.H. (1990). General Biochemistry. Sixth edition. Wiley-Eastern, New Age International Publishers, New Delhi.
21. Wilkins, M.B. (1987). Advanced Plant Physiology, ELBS, Longman, England. Zubay, Geoffrey. (1989). Biochemistry. Mc.Millan Publishing Co. New York.

Paper – BOT-302
Plant Taxonomy and Economic Botany

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The course would deal with the study of the basic concepts of plant taxonomy and botanical nomenclature. The course is also designed to know about the origin of agriculture and economic importance of major crop plants.

Course Outcomes:

CO1 Understand the significance, basic concepts, tools of plant taxonomy
CO2 Learn about the different systems of classification of angiosperms and relevance of plant taxonomy to other branches.
CO3 Acquire knowledge about the plant sources of foods, modern and traditional medicines, spices, oil, fibres, dyes, gum and timbers.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

The Species concept, Taxonomic hierarchy, Species, Genus and Family
Taxonomic evidence: Morphology, anatomy, palynology.
Taxonomic Tools: Herbarium and Floras.
Floral formula and Diagram
Botanical Gardens and herbaria in India; Botanical Survey of India its organization and role.

Unit-II

Salient Features of the International Code of Nomenclature (ICN).
Systems of angiosperm classifications of Benthom and Hooker, Engler and Prantl, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne,
Relative merits and demerits of these systems.

Unit-III

Origin of agriculture: World centers of primary diversity of domesticated plants.
Origin, botany, cultivation and uses of cereals (wheat, rice), Sugarcane, Potato
Oil yielding plants (groundnut, mustard, sunflower)

Unit-IV

Botany, origin, uses of important fibres (Cotton, Jute),
General account of important spices (Ginger, Turmeric, Cinnamon, Clove, Cardamom, Chilies, Pepper, Fennel, Coriander, Cumin, Asafetida, Nutmeg, Mace, and Saffron),
General account of important medicinal plants (Aconite, Cinchona, Belladonna, Digitalis, Glycyrrhiza, Rauvolfia, Papaver, Vasaka, Aloe and Ginseng). A brief account of major Indian Medicinal plants(Amla, Neem, Arjun, Harad, Bahera, Isabgol, Ashwagandha, Bhringraj and Senna)
General account of important timber, dye, gums and tannin yielding plants

Suggested Readings:

1. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc.
2. Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan C., New York.
3. Davis, P.H. and Heywood, V.H. 1965. Principles of Angiosperm Taxonomy. D Van Nostrand Co. , New York.
4. Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., New Delhi.
5. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
6. Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
7. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
8. Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
9. SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi
10. Judd, W.S.; Campbell. C.S., Kellogg, E.A. and Stevens, P.F. 1999. Plant Systematics A Phylogenetic Approach. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, U.S.A.
11. Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
12. Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.
13. Hancock. J. F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing, Cambridge, MA USA.
14. Radford, A. E., W. C. Dickison, J. R. Massey, C. R. Bell. 1976. Vascular Plant Systematics Harper and Row, New York

Paper-BOT-303
Plant Biotechnology and Genetic Engineering

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: This course is intended to provide knowledge about Recombinant DNA Technology, DNA cloning, gene amplification, genetic transformation methods and transgenic plants.

Course Outcomes:

CO1 The students will have better understanding of various tools and techniques of genetic engineering.

CO2 During the course students will gain in depth knowledge about different methods for genetic transformation of plants.

CO3 The students will acquire understanding of production of transgenic plants for biotic and abiotic stress resistance, male sterility and edible vaccines.

CO4 During the course students will gain in depth knowledge about gene cloning methods, PCR and fermentation technology.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Techniques used in DNA Technology: Gel Electrophoresis, PFGE, Southern and Western blotting, Dot blots, Chemical synthesis of genes, DNA chip technology.

Isolation of genes, Sequencing of genes: Maxam & Gilbert's method, Sanger's method and next- generation sequencing technologies,

Brief account of proteomics and genomics.

Unit-II

DNA cloning methods, using vectors (Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC), cloning in bacteria and eukaryotes, genomic and C-DNA Libraries.

Gene amplification by PCR: different types, DNA finger printing, molecular probes: General features and applications.

Unit-III

Gene transfer methods in plants: plasmid mediated, electroporation, cation precipitation, liposomes, microinjection and particles gun technology, expression of transgenes.

Transgenic plants: production of transgenic plants with respect to insect resistance, herbicide resistance, resistance against biotic and abiotic factors, transgenics for male sterility and edible vaccines

Unit-IV

Yeast and algal biomass as source of single cell protein, oils and vitamins, microbial fermentation technology in food industry.

Plant and microbial biopesticides, bioremediation and phytoremediation.

Suggested readings

1. Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-44- Transgenenic Trees, Springer Pub., New York, USA
2. Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-46-Transgenic Trees, Springer Pub., New York, USA
3. Brown, T.A. 1999 Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore
4. Dawson, M.T. Powell, R, and L. Gannon, F.1996. Gene Technology, BIOS Sci. Pub. Ltd., Oxford, UK.
5. Erlich, H.A.(Ed.) 1989, PCR Technology – Principles and applications for DNA Amplification, Stockton Press, New York, USA
6. Glazer, A.N. and Nikaido, H. 1995. Microbial Biotechnology, W.H. Freeman & Company, New York, USA
7. Glover, D.M. and Hames, B.D.(Eds.) 1995. DNA Clonning 1 – A Practical Approach, OIRL Press, Oxford, UK
8. Gupta, P.K. 1996. Elements of Biotechnology, Rastogi & Co., Pub., New Pub., Meerut, India.
9. Hammond, J., McGarvey, P. And Yusibov, V. (Eds.) 1999. Plant Biotechnology – New Products and Applications. Springer Pub., New York, USA.
10. Henry, R.J. 1998. Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK
11. Keller, G.H. and Manak, M.M. 1993. DNA Probes, Mac Millan Pub. Ltd. UK.

12. Lea, P. And Leegood, R.C. 1999. Plant Biotechnology and Molecular Biology (2nd Ed.) John Wiley & Sons, Ltd., England.
13. Lewin, B. 2005. Genes VIII,Osford University Press, Oxford, UK
14. Lindsey, K. And Jones, M.G.K. 1990. Plant Biotechnology in Agriculture, Prentice Hall Int. Pub., London, UK
15. Malaacinski, G.M. and Freifilder, D. 1998. Essentials of Molecular Biology 3rd Ed.), Jones & Bartlett Pub., London, UK
16. Miesfield, R.L. 1999. Applied Molecular Genetics, Wiely Liss, New York, USA.
17. Nicklin,J., Graeme-Cook, K.Paget, T. And Killington, R. 1999. Instant Notes in Mircobiology, VIVA Books Pvt. Ltd., New Delhi, India
18. Purohit, S.S., Kothari, P.R. and Mathur, S.K. 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. Bikaner, India.
19. Rehm;, H.I. and Reed, S.G. (Eds.) 1995. Fundamentals of Genetic Engineering, Pallicut, London, UK.
20. Scragg, A. 1999. Environmental Biotechnology, Pearson Education Ltd., England, UK
21. Shantharam, S. And Montogomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Pub. Pvt. Ltd., New Delhi, India.
22. Sheehan, D. (Ed.) 1997. Bioremediation Protocols, Humana Press, Totowa, USA
23. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Ed.) John Wiley & Sons. Inc., New York, USA
24. Trehan, K. 1990. Biotechnology, New Age Int. Pvt. Ltrd. New Delhi India.
25. Twyman, R.M. 1999. Advanced Molecular Biology, VIVA Books Pvt. Ltd., New Delhi, India.

Paper – BOT-304(a)
ADVANCED PHYCOLOGY-I (ELECTIVE)

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: To acquaint the PG students with importance of Phycology (Algology) towards its contribution to the famous ***'Green Revolution'*** of the nation, thereby making India self-reliant in food grain production.

Course Outcome:

CO1 To acquaint the PG students with importance of Phycology (Algology) towards its contribution to the famous ***'Green Revolution'*** of the nation, thereby making India self-reliant in food grain production.

CO2 To come out with the trained professionals having the knowledge of nutritional requirements of algae for their mass/ large scale cultivation with particular reference to ecological biodiversity of algae & algal bio-fertilizers in Haryana.

CO3 The Course has been conceived to equip the students with the knowledge of various laboratory conditions for their culture and maintenance of algae in terms of their control in water supplies, on ancient monuments and Paddy field algal flora as the **N_2-economy builders** of the nation.

CO4 The Course has been conceived to equip the students with the knowledge of various physiological and biochemical aspects on algal flora exposed to pesticides, toxicants and heavy metals to comprehend the mechanisms of adaptation against them in terms of their uptake kinetics.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1) Limits to algal growth in natural waters.
2) Dynamics and consequences of freshwater marine & algal blooms; Causative factors for eutrophication and its impact.
3) A brief account of phycological researches in India.

Unit-II

4) Mineral nutrition in algae with emphasis on Calcium, Magnesium, Sodium, Iron, Molybdenum, & Silica.
5) Synchronous & continuous cultures and their uses; Physiology of nutrient regulated algal growth.
6) A brief account of culture techniques, media for algal growth and measurement techniques.

Unit-III

7) Algae in water supplies, on ancient monuments and bio-fouling of ships.
8) Ecological biodiversity of algae in unusual habitats with suitable examples.
9) Paddy field algal flora as N_2-economy builders of the nation.

Unit-IV

10) Physiological and biochemical aspects on algal flora exposed to heavy metals.
11) Kinetics of heavy metal uptake and its bioaccumulation.
12) Mechanisms of adaptation against tolerance to toxicants, pesticides and salt.

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* Daya Publishing House, New Delhi. 2003.
2. Becker, E.W. (1994): Microalgae – Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.
3. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific
4. Publ., Oxford, U.K.
5. Dubey, R.C. (2006): Introduction to Biotechnology, Delhi Book Trust, New Delhi.
6. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
7. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental
8. Biotechnology, Narosa Publihers.
9. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V.
10. Amsterdam, Netherlands.
11. Graham, L.E. & Wilcox, L.W. (1999): Algae, Benjamin Cummings, USA.
12. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing

Paper – BOT-304(b)
APPLIED MYCOLOGY (ELECTIVE)

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: The course has been envisaged to make the students aware about the role of fungi in Industry, as biofertilizer, as biocontrol agents, and biodeteriorating agents. Besides this, the course will be helpful in acquainting the students with the various techniques of culturing and isolation of fungi from various sources, culture media and preservation of fungi.

Course Outcomes:

CO1 Production of Valuable microbial products.
CO2 Role of Fungi as biofertilisers and biocontrol agents.
CO3 Techniques used for maintenance of fungal cultures. .
CO4 Commercial production of mushrooms.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Primary metabolites production by fungi: industrial alcohol, organic acid, beer.
Secondary metabolites production by fungi: Antibiotics, steroid transformation,. Enzymes, amino acids, growth regulators, vitamins

Unit-II

Fungi as biofertilizers: Endomycorrhizae and ectomycorrhizae.
Fungi as biocontrol of plant pathogens and weeds.
Biodeterioration of materials: Paper, painted surface, wood.

Unit-III

Food processing by fungi: Bread, cheese, oriental food and baker's yeast.
Fungal sources of health food: Single cell protein, edible mushrooms.
Spoilage of food and fungal toxicity.

Unit-IV

Culturing and preservation of fungi: isolation of fungi, culturing of fungi, establishing a pure culture, aseptic technique, maintenance of culture collection, culture collection and identification centres.
Common culture media and sterilization techniques.

Suggested Readings:

1. Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.
2. Bilgrami, K.SA. & Verma R.N. (1981): Physiology of fungi, Vikas Publ. Ltd., New Delhi.
3. Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.
4. Butler, E.J. & Jones, S.G. (1976): Plant Pathology, Periodical Expert Book Agency, New Delhi.
5. Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.
6. Dubey, R.C. (2005): A Text Book of Biotechnology, S Chand & Co. Ltd., New Delhi.
7. Bilgrami, K.S. & Dubey H.C. (1986): A text book of Modern Plant Pathology, Vikas, Publ. Ltd., N.Delhi.
8. Gupta, R. & Mukerji, K.G. (2001): Microbial Technology, APH Publ. Co., New Delhi.
9. Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, N. Delhi.
10. Michael J. Pelezar, E.C.S. Chaing & N.R. Krieg, 1993: Microbiology. Tata McGraw Hill Publ. N. Delhi.
11. Mundukur, B.B. (1967): Fungi & Plant Diseases, Pochillion Co. Ltd., USA.
12. Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm. C. Brown Publ., USA.
13. Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
14. Moore-landeckar, E.J. (1972): Fundamentals of the fungi, Prentice Hall, Eaglewood, U.K.
15. Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.

Paper – BOT-304(c)
RESTORATION ECOLOGY (ELECTIVE)

Course Objectives: To develop the abilities of students to critically engage with concepts and theory in Restoration ecology from interdisciplinary perspectives and at an advanced level.
Course Outcomes: Student will be able to embrace the implications of the basic principles of restoration ecology for the future of restoration of degraded ecosystems and their management.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1) Restoration-Terms and definitions, Importance of ecological restoration: strategies of Restoration-Natural recovery, active restoration, rehabilitation.
2) Restoration plan and rehabilitation measures.
3) Natural and anthropogenic disturbances: Characteristics and sources, effects on structural and functioning of terrestrial and aquatic ecosystems.

Unit-II

4) Rehabilitation of salt affected soils.
5) Prevention and mitigation of invasive species; Habitant fragmentation.
6) Ecosystem stability: Structural and functional stability.
7) Climate change mitigation and Biological carbon sequestration.

Unit-III

8) Sustainable forestry management and agroforestry.
9) Biotechnological Tools of Restoration.
10) Environmental impact and risk assessment.

Unit-IV

11) Degradation and Restoration of forest and grassland ecosystems.
12) Degradation and restoration of aquatic resources: River corridors, wetlands and lakes. Adaptive restoration of wetlands; Waste water recycling and waste management.
13) Reclamation of mining sites, Bioremediation and Phytoremediation.

Suggested Readings :

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Carson, Rachel . 1962. Silent spring. Boston, Houghton Mifflin
3. Manahan, S.E. 2000. Environmental Chemistry. Seventh Edition. Lewis Publishers, New York
4. Mitsch, W.J. and Jorgensen, S.E. (eds.) 1989. Ecological Engineering: An Introduction to Ecotechnology. John Wiley and Sons, New York.
5. Morgan, R.K. Environmental Impact Assessment; A methodological Perspective. Kluwer Academic Publishers, London.
6. Pierzynski, G.M., Sims, J.T. and Vance, G.F. 2000. Soils and Environmental Quality. Second Edition. CRC press, New York.
7. Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
8. Bradshaw, A.D. and Chadwick, M.J. (1980). The Restoration of Land Ecology and Reclamation f Derelict and Degraded Land Blackwell Scientific Publication, Oxford, England. 9. Pace, M.L. and Groffman, P.M. (Eds.) (1998). Success, limitations and Frontiers in Ecosystem Science, Springer Verlag, New York.
10. Packard, S. And Mutel C.F. eds. (1997). The Tall Grass Restoration Handbook, Island Press, Washington, DC.
11. Petts, G. And Calow P. Larsen, P. (1996). River Restoration a Blackwell Science, Oxford, England.
12. Urbanska, K.M. Webb, N.R. and Edwards, P.J. (1998). Restoration Ecology and Sustainable Development. (Cambridge University Press, Cambridge).
13. USEPA (2000). Principles for the Ecological Restoration of Aquatic Resources. EPA 841-F-00-003. Office of Water (4501F), United States Environmental Protection Agency, Washington, DC. 4pp.

Paper – BOT-304(d)
ADVANCED PLANT PHYSIOLOGY (ELECTIVE)

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: The course would deal with advances in plant physiology especially photosynthesis, respiration and responses of the plants to abiotic stresses.

Course Outcomes:

CO1 The students will be able to understand the physiological and biochemical basis of drought stress and its manifestation in plant productivity.

CO2 The students will be well acquainted with the mechanisms of salt and temperature stresses.

CO3 The learners will acquire the indepth knowledge of process of photosynthesis and the translocations of photosynthates from source to sinks.

CO4 The students will enhance their knowledge regarding mechanism of respiratory cycle in plants and the methods of estimation of respiration.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Water stress: Drought, its definition and quantification, water deficit and plant growth, physiological and biochemical functions, responses injury affected by drought, Adaptive strategies for drought resistance. Osmotic adjustment, osmoprotectants. Water logging/ oxygen deficiency and its effects on plant growth.

Unit-II

Salt and temperature stress: Salt stress; Saline and alkaline soils, salt stress injury, mechanism of salt stress and halophytes. Temperature stress; high temperature stress, heat shock proteins, chilling and frost injury and mechanism of tolerance.

Unit-III

Photosynthesis: The four major complexes of thylakoids. The path of carbon in photosynthesis (C3, C4 and CAM plants) Rubisco, structure and its association with the mechanism of carboxylation and oxygenation of RUBP. Effect of environmental factors on photosynthetic rates. Translocation of photosynthates and its importance in sink growth

Unit-IV

Respiration: Cyanide insensitive respiration: Mechanism and significance. Comparison between normal electron transport chain and alternate oxidase pathway of respiration. Glycolic acid metabolism and photorespiration. Glyoxylate cycle. Respiration in intact plants and tissues.

Suggested Readings:

1. Bonner, J. And Varner, J.E. (1976) Plant Biochemistry, Academic Press, New York and London (Third Edition).
2. Buchanan, B.B., Gruissem, w. And Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
3. Cooper, T.G. (1977). Electrophoresis. In : The Tools of Biochemistry. John Wiley and Sons., New York.
4. Dey, P.M. and Harborne, J.B. (1997), First Indian edition, 2000). Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.
5. Noggle, G.r. and Fritz, G.J. (1983). Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition (Seventh reprint, 1992).
6. Salisbury, F.B. and Ross, G.W. (1992). Plant Physiology. Fourth Edition, Wadsworth Publishing Co. Belmont, California, USA.
7. Sawhney, S.K. and Singh, Randhir. (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
8. Solmos, T. (1977). Cyanide resistant respiration in higher plants. In:Ann. Rev. Pl. Physiol.28:279-297.

Paper – BOT-304(e)
Biophysical and Biochemical Techniques (ELECTIVE)

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: This paper aims to provide an introduction to various tools and techniques used to gain insight into cell structure and biological processes. The focus is on studying the techniques used for isolation, purification and characterization of biomolecules.

Course Outcomes:

CO1 This course will provide the students in-depth knowledge of microscopic technology.

CO2 The students will understand the various methods used in separation, purification and quantification of biomolecules.

CO3 It will provide the students a basic understanding of the techniques used for the identification of various macromolecules.

CO4 The students will know about the tools used for tracing the metabolic pathways.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. **Microscopic techniques**: Introduction; Light microscope; Phase contrast microscope; Fluorescent microscope; Electron microscope (EM) – SEM, TEM and STEHM; Scanning probe microscopes- scanning 26itrogeni microscope and atomic force microscope; Different fixation and staining techniques.
2. **Centrifugation**: Principles of sedimentation; Types, care and safety aspects of centrifuges; Differential centrifugation; Density gradient centrifugation and their applications.

Unit-II

3. **Chromatographic techniques**: Theory of chromatography; Types of chromatography- Paper chromatography, Thin layer chromatography, Adsorption chromatography, Partition chromatography, Affinity chromatography, Ion exchange chromatography, HPLC and Size-exclusion chromatography.
4. **Spectrophotometery**: Colorimetery; UV and Visible spectrophotometery.

Unit-III

5. **Electrophoresis**: Principle; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; 2-Dimensional gel electrophoresis; Capillary electrophoresis; Microchip electrophoresis and Isoelectric focusing.
6. **Mass spectrometry:** Introduction; Theory; Mass spectrometer; Ionization of molecules; Mass analysers- MALDI; Detectors and Applications.

Unit-IV

7. **Immunotechniques**: Antibody generation; Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells.
8. **Radioisotope techniques**: Radioactive isotopes; Nature of radioactivity; Detection and measurement of different types of radioisotopes normally used in biology; Incorporation of radioisotopes in biological tissues and cells; Molecular imaging of radioactive material; Disposable of radioactive wastes and safety guidelines.

Suggested Readings:

1. Hegyi G, Kardos J, Kovacs M, Csizmadia AM, Nyitray L, Pal G, Radnai L, Remenyi A Venekei I (2013) Introduction to Practical Biochemistry, Eotvos Lorand University, Hungary.
2. Plummer DT (1990) An Introduction to Practical Biochemistry, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.
3. Prescott L and Harley J Klein D (2005) Microbiology (6th Ed) Mc Graw-Hill.
4. Ranade R and Deshmukh S (2013) Handbook of Techniques in Biotechnology, Studium Press (India) Pvt. Ltd. New Delhi.
5. Sawhney SK and *Singh R (2000)* Introductory *Practical Biochemistry (Ed.),* Narosa Publishing House Pvt. Ltd., New Delhi.
6. Wilson K and Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th Ed.), Cambridge University Press, New Delhi.

Paper – BOT-401

PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The course would deal with different aspects of plant growth and development especially germination and dormancy of seeds, plant growth regulators, senescence and abscission, photomorphogenesis and response of plant to different abiotic stresses.

Course Outcomes:

CO1 The students will be able to understand the basic concepts of plant growth and development.

CO2 The students will be learning about abiotic stress tolerance/adaptive physiological changes affecting plant productivity.

CO3 During the course students will gain in depth knowledge about various plant growth regulators and their role in physiology of growth and development.

CO4 Students will be acquainted with the knowledge of physiology of flowering and sensory biology.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Plant Growth: Growth concepts, Growth curves, Growth analysis.

Germination and Dormancy of seeds; factors affecting dormancy and its regulation by plant growth regulators and environmental factors.

Stress Physiology: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.

Unit-II

Plant Growth Regulators: Discovery, biosynthetic pathways, transport, influence on plant growth and mechanism of action of: Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid.

Unit-III

Senescence and Abscission: Physiological and biochemical changes associated with senescence and abcission.

Tropism: Phototropism, nature of receptors, role of hormones, Geotropism and nastism.

Unit-IV

Sensory Photobiology:

Phytochromes: mechanism of phytochrome action, photomorphogenesis and cryptochromes. The Flowering Process: Photoperiodism and its significance, importance of dark periods, role of vernalization. Nature and events during flowering, florigen concept, chemical control of flowering.

Suggested Readings:

1. Audus, L.J. (1972). Plant Growth Substances. Vol.I Chemistry and Physiology. Leonard Hill, London.
2. Bonner, J. And Varner, J.E. (1976). Plant Biochemistry,IIIrd Edition, Academic Press, New York and London.
3. Buchanan, B.B., Gruissem, W. And Jones, R.L. (2000). Biochemstry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
4. Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.
5. Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt.Ltd.
6. Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.
7. Hopkins, W.G. 1995 Introduction to Plant Physiology, John Wiley and Sons.
8. Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
9. Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East- West Press Pvt Ltd. New Delhi.
10. Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India
11. Lehninger, A.L, Nelson, D.L. and Co MM 1993 Principles of Biochemistry Second edition, CBS Publishers.
12. Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing

House, New Delhi..
13. Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology, Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.
14. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, Wadsworth Publishing Co. Belmont, California, USA.
15. Singhal, G.S. Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (editors) (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
16. Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
17. Taiz, L and Zeiger, E. (1998). Plant Physiology. Second edition. Sinauer Associates, Inc., Publishers, Massachusetts, USA
18. Trehan, K. (1990). Biochemistry. Second edition, Wiley-Eastern Ltd., New Delhi.
19. Trivedi, P.C. (2005). Applied Botany. Aavishkar Publishers, Distributors, Jaipur.
20. Trivedi, P.C. (2006). Plant Molecular Physiology: Current Scenario and Future Projections. Aavishkar Publishers, Distributors, Jaipur.
21. Weil, J.H. (1990). General Biochemistry. Sixth edition. Wiley-Eastern, New Age International Publishers, New Delhi.
22. Wilkins, M.B. (1987). Advanced Plant Physiology, ELBS, Longman, England.
23. Zubay, Geoffrey. (1989). Biochemistry. Mc.Millan Publishing Co. New York.

Paper – BOT-402
Biology of Reproduction and Anatomy

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The course would deal with history of Embryology. It also describe the technique and applications of *in vitro* culture of reproductive organs.

Course Outcomes:

CO1 Describe the structure and development of reproductive structures and the process of reproduction in angiosperms
CO2 Acquire knowledge about *in vitro* culturing techniques and their applications in human welfare.
CO3 Learn about the role of anatomy in taxonomy and anomalous secondary structures in plants

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit I

History of plant embryology
Male gametophyte: structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; Pollen germination, pollen tube growth and guidance; pollen allergy

Unit II

Female gametophyte; ovule development, megasporogenesis; Organization of the embryosac, structure of the embryo sac cells. Pollination, Pollination mechanisms and vectors.

Unit III

Pollen pistil interaction and fertilization; structure of pistils; pollen-stigma interaction, sporophytic and gametophytic incompatibility, double fertilization, Endosperm development, polyembryony; apomixes. Experimental Embryology: in vitro fertilization Anther, Pollen and embryo culture,

Unit IV

Anatomy in relation to taxonomy. Anomalous secondary Structure: Anomalous secondary growth, anomalous position of cambium, abnormal behaviour of normal cambium, accessory cambium formation and its activity, extrastelar cambium, Interxylary and intraxylary phloe, presence of medullary bundles, cortical bundles, presence of exclusive phloem and xylem bundles, secondary growth in monocots.

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.
2. Shivanna, K.R. and Johri, B.M. 1985. The Angiopsrem Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi.
3. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge Univ. Press, Cambridge.
4. Johri, B.M. (ed.) Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin,
5. Esau, K. 1965. Plant Anatomy. John Wiley & Sons New York.
6. Fahn, A. 1967.Plant Anatomy. Pergamon Press, London, New York.
7. Eames , A.J. and MacDaniels, L.H. 1947. An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New York.
8. Eames, A. J. 1961. Morphology of Angiosperms. McGraw Hill Book Company, New York

Paper – BOT-403
Plant Tissue Culture

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: This course seeks to impart detailed knowledge of micropropagation, somatic embryogenesis, haploid production, somatic hybridization, cryopreservation and secondary metabolite production.

Course Outcomes:

CO1 This course will impart knowledge to students for non-conventional multiplication of plants.
CO2 Students will learn about regeneration of complete plants from plant organs/cell other than seeds.
CO3 Students will be able to apply knowledge regarding in vitro techniques in Agriculture and forestry.
CO4 Students will attain practical knowledge of preparing artificial seeds.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit I

1. History of Plant Tissue Culture, Basic concept, principles and scope of plant cell and tissue culture, concepts of cellular differentiation; Totipotency; basic techniques of plant tissue culture; callus formation, organogenesis and embryogenesis.
2. Protoplast isolation, fusion and culture, somatic hybridization, hybrid selection and regeneration. Cybrids and their application.

Unit-II

3. *In vitro* haploid production and its significance, Anther/Pollen culture and ovary culture; Embryo and ovule culture Production of triploids through endosperm culture.
4. Micropropagation: meristem culture and virus-free plants; Cryopreservation of plant cell and tissue cultures and establishment of gene banks.

Unit-III

5. Somaclonal variations and isolation of useful mutants; mechanisms and applications in genotype improvement.
6. Role of plant cell cultures in Bioreactor types and application in cell culture and secondary metabolite production.

Unit-IV

7. Somatic embryogenesis, production of synthetic seeds, importance, limitation and their utilization.
8. Application of tissue culture in forestry and agriculture; status of tissue and cell culture technology in India edible vaccines, and their prospects

Suggested Readings

1. Ammirato, P.V., D.A. Evans, N.D. Sharp and Y.P.S. Bajaj (1990). Hand Book of Plant Cell Culture, Vols. 1-5. McGraw Hill Publishing Company, New York.
2. Bhojwani, S.S. and Razadan, M.K. 1996. Plant Tissue Culture: Theory and Practice (A revised Edition), Elsevier Science Pub., New York, USA
3. Collins, H.A. and Edwards, S. 1998, Plant Cell Culture, Bios Scientific Pub., Oxford, U.K.
4. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs, CRC Press, Boca Raton, Florida, U.S.A.
5. Razadan, M.K. 1993. An introduction to Plant Culture. Oxford & IBH Pub., Co., New Delhi, India

Paper–BOT-404(a)
ADVANCED PHYCOLOGY-II (ELECTIVE)

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: To impart knowledge about the wider perspectives of the ***'Nitrogen economy builders of the nation'*** in the context of fast changing industrializing Haryana as well as which has been traditionally an agricultural economy.

Course Outcomes:

CO1 Student will be able to understand the fundamental principles and philosophy of restoration ecology.
CO2 Students will be able to understand the significance of disturbances affecting structure and functions of different types of ecosystems.
CO3 Students will develop insights into degradation of ecosystems (terrestrial and aquatic) and their restoration by application of ecological principles.
CO4 This course emphasizes critical analysis of restoration approaches used in case studies.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1)Photosynthesis and Chromatic adaptations in algae: pigments, photosynthetic membrane organization, oxygenic & anoxygenic photosynthesis.
2) Relationship of CO_2-assimilation with nitrogen assimilation: source of energy & reductants.
3. Nutrient uptake kinetics in algae.

Unit-II

4) Importance of N_2-fixing genera in Indian paddy fields for the improvement of soil fertility.
5) Heterocyst, its differentiation and role in N2-fixation.
6) Mechanism N_2-fixing fixation: nitrogenise and its *in vivo* activity.
7) Uptake kinetics of nitrogenous compounds, their transport and assimilation.

Unit-III

8) Algal immobilization: methods and applications.
9) Technologies for the reclamation, restoration & maintenance of ***usar*** soils and its fertility.
10) Restoration of degraded ecosystems through algae. Importance of algal flora for the treatment of wastewaters (activated sludge system) for the production of useful biomass & energy-rich fuel.

Unit-IV

11) Concept of algalization and biofertilizers.
12) Strain improvement for the production of nitrogenous compounds. Biological & technical aspects of outdoor mass culture of algae.
13) A brief account of commercial potentials of algae, algal products & their uses.

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* Daya Publishing House, New Delhi. 2003.
2. Becker, E.W. (1994): Microalgae – Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.
3. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
4. Dubey, R.C. (2006): Introduction to Biotechnology, Delhi Book Trust, New Delhi.
5. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
6. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publihers.
7. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
8. Graham, L.E. & Wilcox, L.W. (1999): Algae, Benjamin Cummings, USA.

Paper – BOT-404(b)
PRINCIPLES OF PLANT PATHOLOGY (ELECTIVE)

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The course has been conceived to equip the students with mechanism of infection of fungi, various defence mechanism employed by the plants to protect themselves against plant pathogens. Besides, the course deals with epidemiology, role of environmental factors for disease development, disease forecasting, applications of biotechnology in plant pathology and methods adopted for disease management.

Course Outcomes:

CO1: Various mechanisms involved during pathogenesis.
CO2: Plant disease epidemiology, forecasting and management
CO3: Applications of biotechnology in plant pathology
CO4: Host-pathogen interactions and mycotoxins

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

How pathogens attack plants : chemical weapons of pathogens (enzymes and toxins)
How plants defend themselves against pathogens: structural defense and biochemical defense.

Unit-II

Plant disease epidemiology and plant disease forecasting: Importance of disease forecasting services, methods used in plant disease forecasting.
Management of plant pathogens: cultural, chemical and biological methods.

Unit-III

Applications of biotechnology in Plant Pathology: The use of tissue culture techniques (callus culture, apical meristem culture and protoplast fusion), Recombinant DNA technology, use of monoclonal antibodies in plant pathology.
Effect of environmental factors on disease development.

Unit-IV

Mycotoxin producing fungi during storage and major mycotoxins produced by them.
Host-pathogen interaction of population level: transmission and spread of plant pathogens.

Suggested Readings:

1. Agrios. G.N. (2005): Plant Pathology, Acad. Press, Inc. California.
2. Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.
3. Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.
4. Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.
5. Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, New Delhi.
6. Mehrotra, R.S. and Ashok Aggarwal (2003): Plant Pathology, Tata Mc Graw Hill Publ. Ltd., New Delhi.
7. Michael J. Pelezar, E.C.S. Shan & N.R. Krieg (1993): Microbiology. Tata Mc Graw Hill Publ. New Delhi.
8. Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
9. Singh, R.S. (1990): Plant Disease, 6th Edition, Oxford, IBH Publ., New Delhi.
10. Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.
11. Webster, J. (1985): Introduction of Fungi. Cambridge University, Press.

Paper – BOT-404(c)
CONSERVATION BIOLOGY (ELECTIVE)

Total Marks: 100
Theory Marks: 80
Internal Marks:20
Time: 3 Hours

Course Objectives: The student will be able to appreciate the value of Biodiversity and focus on the relationship between living organisms and the terrestrial, freshwater and marine environments, coupled with the interactions that results from natural and anthropogenic processes.

Course Outcomes:

CO1 Students will become aware and understand the concept and significance of different conventions and Protected Area Networks in relation to conservation of Biodiversity.

CO2 Students will be able to develop own conservation values and ethics and appreciate the importance of biodiversity services.

CO3 Student will be able to develop the skills necessary to work efficiently in areas like conservation, EIA, environment management and monitoring.

CO4 After completion of the course, the student be able to formulate one's own scientific and realistic approach towards Conservation Biology.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1) Principles, characteristics and importance of conservation biology
2) Conservation values and ethics, Role of species in conservation

Unit-II

3) Global biodiversity I: Patterns and Processes
4) Global biodiversity II: Losses, Pattern of species vulnerability, Habitat fragmentation and degradation, Synergistic interactions
5) Biodiversity and ecosystem services

Unit-III

6) Biodiversity of wetlands, mangroves and coral reefs- A general account
7) Biosphere reserves and RAMSAR sites in India, The Design of Conservation Reserves
8) Major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere Reserves)

Unit-IV

9) Importance of genetic resources and conservation of crop genetic resources
10) International and National efforts to conserve biodiversity: Convention on biological diversity, CITES, Ramsar convention; National Biodiversity strategy
11) Role of remote sensing and GIS and biodiversity conservation

Suggested Readings :

1. Chape, S., Fish, L., Fox, P. And Spalding, M. 2003. United Nations list of protected areas. IUCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge
2. Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk bv. The Hague.
3. Heywood, V.(Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.
4. Hunter (Jr.) M.L. (1996); Fundamentals of Conservation Biology, Blackwell Science. Meffe G.K. and C. Ronals Corroll (1994) Principles of Conservation Biology, Sinaur Associates, Inc., Sunderland. Massachusetts.
5. Huston, M.A. 1994. Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
6. Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley

7. & Sons Inc., New York.
8. Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
9. Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.
10. Turner, M.G., Gadner,R.H. and O,Neill, R.V. 2001. Landscape Ecology: In theory and Practice, Pattern and Processes. Spinger Verlag, New York.

Paper – BOT-404(d)
PLANT GROWTH REGULATORS (ELECTIVE)

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: The course would deal with the study of regulation of different growth regulators to fruit and seed physiology. The advances in senescence, abscission and mechanism of action of various phytohormones will also be studied.

Course Outcomes: The students will be well acquainted with:
CO1 Biosynthesis, regulation and mechanism of actions of various plant growth regulators.
CO2 The metabolism of seed viability and dormancy and their control.
CO3 Metabolic changes associated with the senescence and abscission and their hormonal control.
CO4 Physiological and biochemical changes of fruit ripening and post harvest storage of fruits.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Phytohormones

Recent advances in the biosynthesis and regulation of cytokinins and ethylene
Current scenario in the mechanism of action of gibberellins, abscisic acid, salicylic acid, jasmonic acid and brassinosteroids.

Unit-II

Seed Physiology
Seed viability and seed dormancy
Metabolism of germinating seeds.
Environmental and hormonal control of seed dormancy and germination.

Unit-III

Senescence and Abscission
Process of induction
Metabolic changes.
Role of plant growth regulators
Fruit Physiology

Unit-IV

Climacteric and non-climacteric fruits, fruit ripening.
Post-harvest storage of fruits – quality maintenance, physiological and biochemical studies under different kinds of storage conditions.

Suggested Readings:

1. Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
2. Khan, A.A (1977). The Physiology and Biochemistry of Seed Dormancy and germination. North-Holland Publishing Co., Amsterdam, New Oxford.
3. Moore. T.C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi.
4. Saymour, G.B., Taylor, J.E. and Tucker, G.A. (1993). Biochemistry of Fruit Ripening. Chapman and Hall, London.
5. Stahl, E. (1965). Thin Layer Chromatography, a laboratory handbook. Academic Press, London.
6. Taiz, L. And Zeiger, E. (1998). Plant Physiology. Second edition, Sinauer Associates, Inc., Publishers, Massachusetts, USA.
7. Wilkins, M.B. (1987). Advanced Plant Physiology. ELBS-Longman, England.
8. Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
9. Trivedi, P.C. (2005). Applied Botany. Aavishkar Publishers, Distributors, Jaipur.

Paper – BOT-404(e)
GENOMICS (ELECTIVE)

Total Marks:	**100**
Theory Marks:	**80**
Internal Marks:	**20**
Time:	**3 Hours**

Course Objectives: This course seeks to impart detailed knowledge of basic methods involved in genome studies. their organization and function.

Course Outcomes:

CO1 The students get acquainted about the basic principles of DNA sequencing and evolution of DNA sequencing techniques.

CO2 Help the students to understand methods/techniques employed in proteome and genome analysis.

CO3 This course will enable the students to learn about the various databases utilize for the storage and analysis of proteome/genome information.

CO4 The students will learn about the various computational tools used for analysis of genome sequence data.

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. **Genome**: Completely sequenced prokaryotic (T_4, and λ phages; *E. coli*) and eukaryotic genomes (*Saccharomyces cerevisiae, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana, Oryza sativa, Mus musculus* and *Homo sapiens*); Mitochondrial and Chloroplast genomes.
2. **Mapping of Genome**: Genetic mapping- using DNA markers and Linkage analysis; Physical mapping- restriction mapping, Fluorescent *in-situ* hybridization and Sequence Tagged Sites (STSs) mapping.

Unit-II

3. **Genome sequencing**: Chain termination and chemical degradation methods; Next generation sequencing (NGS)-Pyrosequencing. SOLiD sequencing, Bridge amplification sequencing, Assembly of a contiguous DNA sequence-shotgun and clone contig methods, Human Genome Project.
4. **Understanding a Genome Sequence**: Gene location using 1.) ORF scanning, Automatic annotation, Homology searches and comparative genomics. 2.) Experimental techniques- northern hybridization, cDNA sequencing and RACE.

Unit-III

5. **Identification of a Gene Function**: Using computer analysis; Experimental analysis- gene inactivation and overexpression; Directed mutagenePsis; Reporter genes and Immunocytochemistry.
6. **Analysis of the Transcriptome**: Expressed Sequence Tags (ESTs); Serial analysis of gene expression (SAGE); Differential Display (DD); Representational Difference Analysis (RDA) and DNA Microarrays.
7. **Proteome Analysis:** Using 2-D; Protein identification; Protein-DNA and Protein- Protein interactions and Biochips.

Unit-IV

8. **Biological Databases**: Introduction; Primary and Specialized Databases; Database Scheme; Database Annotation; Retrieval System; Nucleotide Databases; Protein Databases; Genomic Databases and Resources; Gene Databases and Resources; Transcriptome Databases; Mutation Databases; Mitochondrial Databases and Resources.
9. **Computational Methods for Analysis of Genome Sequence Data**: Introduction; Dot-Plot Matrix; Sequence pairwise alignment; Database searching; Multiple alignment; Alignment profiles to recognize distantly related protein or protein modules; Methods for sequence assembly; Linguistic analysis of biosequences; Prediction of RNA secondary structures; Protein sequence analysis; Evolutionary and phylogenetic analysis.

Suggested Readings:

1. Birren B, Green ED, Klapholz S, Myers RM and Roskams J (1997) Genome Analysis, CSHL Press.
2. Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Brown TA (2002) Genomes 2, Wiley-Liss, New York
4. Brown TA (2007) Genomes 3, Garland Science Publishing New York, London.
5. Chawla HS (2009) Introduction to Plant Biotechnology (3rd Ed.). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Dale JW, Schantz MV and Plant N (2012) From Genes to Genomes (3rd Ed.), John Wiley and Sons, Ltd. UK.
7. Dawson, MT, Powell R and L Gannon F (1996) Gene Technology, BIOS Sci. Pub. Ltd., Oxford, UK. DNA Amplification, Stockton Press, New York, USA.
8. Glick B and Pasternak JJ (2003), Molecular Biotechnology (3rd Ed), ASM Press, Washington.
9. Hartl DL and Ruvolo M (2011) Genetics- Analysis of Genes and Genomes (8th Ed.), Jones and Bartlett Publishers, Inc., USA.

10. Hunt SP and Livesey FJ (2000) Functional Genomics, Oxford University Press, New York. London.
11. Lewin B (2005) Genes VIII, Oxford University Press, Oxford, UK
12. Li WH (1997) Molecular Evolution, Sinauer Associates, Inc., USA.
13. Saccone C and Pesole G (2003), Handbook of Comparative Genomics, John Wiley and Sons, Inc., Hoboken, New Jersey.
14. Sambamurty AVSS (2007) Molecular Genetics, Narosa Publishing House Pvt. Ltd., New Delhi.
15. Singer M and Berg P (1991) Genes and Genomes: A Changing Perspective; University Science Books, CA, USA.

Discrepancy, if any noted by stakeholders may please be brought to the notice of Department of Botany, C.R.S University, Jind for necessary action.