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

**BOTANY DEPARTMENT**

**KURUKSHETRA UNIVERSITY KURUKSHETRA**

**M.Sc. BOTANY Scheme of Examination (CBCS)w.e.f. 2016-17**

**Semester I**

**Semester II**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Paper code** | **Title of paper** | **Type of paper** | **Hours/week** | **Credits** | **Marks + Internal Assessment** | **Total** |
| BOT-201 | Plant pathology & Microbiology | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-202 | Bryophytes | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-203 | Pteridophytes & Gymnosperms | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-204 | Molecular genetics | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-205 | Seminar | Core | 1 | 1 | 25 | 25 |
| BOT-206 | Plants for human welfare | Open Elective | 2 | 2 | 40 + 10 | 50 |
| BOT-207 | Practical based on 201 + 202 | Core | 8 | 4 | 80 + 20 | 100 |
| BOT-208 | Practical based on 203 + 204 | Core | 8 | 4 | 80 + 20 | 100 |
| Total | 27 |  675 |

**Semester III**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Paper code** | **Title of paper** | **Type of paper** | **Hours/week** | **Credits** | **Marks + Internal Assessment** | **Total** |
| BOT-301 | Plant physiology & biochemistry | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-302 | Taxonomy & economic botany | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-303 | Biotechnology & genetic engineering | Core | 4 | 4 | 80 + 20 | 100 |
| BOT-304 | a) Advanced Phycology (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 |
| BOT-305 | Seminar | Core | 1 | 1 | 25 | 25 |
| BOT-306 | Biodiversity and its conservation  | Open Elective | 2 | 2 | 40 + 10 | 50 |
| BOT-307 | Practical based on 301 | Core | 6 | 3 | 60 + 15 | 75 |
| BOT-308 | Practical based on 302 + 303 | Core | 6 | 3 | 60 + 15 | 75 |
| BOT-309 | Practical based on 304 | Core | 4 | 2 | 40 + 10 | 50 |
| Total | 27 |  675 |

**Semester IV**

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

**Total Credits = 102**

**Total Marks = 2550**

**SEMESTER – I**

**Paper – BOT-101 Algae Credit -4 MM-80**

 **Objectives:** To educate and train the students for professional and research career in the field of Algology (Phycology).

**Outcome:** The learning outcome is an advanced academic education to broaden the knowledge in comparison t that obtained in Bechelor’s degree programme. The acquired knowledge provides professional qualification for work in biological laboratories and research centres.

**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.

**UNIT-II**

3. Morphological features and life cycle patterns of major divisions with suitable examples (Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, and Rhodophyta).

**UNIT-III**

4. Biodiversity of algae in different habitats (terrestrial, freshwater and marine).

5. Algal biodiversity in unusual habitats (thermal, psychrophilic, subaerial, symbiotic etc.).

6. Thallus organization in algae and evolutionary trends.

**UNIT-IV**

7. Reproduction (vegetative, asexual and sexual) and life cycle patterns in algae.

8. Dynamics and consequences of algal blooms and red tides (Freshwater and Marine). Algae as major components of phytoplankton.

9. Economic importance of algae as food, feed, uses in industries etc and algal biofertilizers.

**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.

9. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing

House, Daryaganj, New Delhi.

10. Hoek, C. Van Den, Mann, D.G. & Jahns, H.M. (1995): Algae: An Introduction to

Phycology, Cambridge University Press, U.K.

11. Kashyap, A.K. (1994): Recent Advances in Phycology, Rastogi & Company, Meerut.

12. Kaushik, B.D. (1987): Laboratory methods for Blue-green Algae, Associated Publishing

Co., New Delhi.

13. Morris, I. (1980): The Physiological Ecology of Phytoplankton (studies in Ecology,

Vol.7), Blackwell Scientific Publ., USA.

14. Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm. C.

Brown Publishers, USA.

15. Shubert (1984): Algae as Ecological Indicators, Academic Press, U.S.A.

16. Singh, B.D. (1998): Biotechnology, Kalyani Publishers, New Delhi.

17. Singh, R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.

18. Sze, P. (1993): A. biology of the Algae, Wm. C. Brown Publishers, U.K.

19. Trainer, F.R. (1978): Introductory Phycology, John Wiley & Sons, New York, USA.

20. Venkataraman, G.S. ((1969): The Cultivation of Algae, IARI, New Delhi.

**Paper – BOT-102 FUNGI Credit -4 MM-80**

**Objectives**: The course has been designed to acquaint the students with general characters, habit, habitat, somatic organization as well as anamorph and teleomorph stages of different groups of fungi. Further the course has been conceived to make the students aware of compatibility of alternate genetic systems of fungi as well as their role as symbionts and saprotrophs.

**Outcome:** After completion of course the students will understand the general characters of fungi, economic importance and life cycle of various groups of fungi. The students will understand the symbiotic and saprotrophic roles of fungi in agriculture and role of fungi as biocontrol agents and Mycorrhizal fungi as biofertilizer.

**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 characters of fungi:

Definition, thallus organization, cell structure, cell wall composition

 Reproduction- Vegetative, asexual and sexual reproduction

 Fungal classification (Ainsworth, 1973; Hawksworth *et al* 1995; Alexopoulos

 *et al*, 1996),

 Nutrition (saprobic, biotrophic, symbiotic)

 Economic importance of fungi

**UNIT II**

1. Comparative study of habit, habitat, somatic organization, anamorph and teleomorph of the member of :
	1. Dictyosteliomycota and Myxomycota (*Dictyostellium, Physarum*). *Plasmodiophora,*
	2. Chytridiomycota and Oomycota (*Synchytrium, Allomyces, Pythium, Phytophthora*

and Downy mildews).

* 1. Zygomycota (*Rhizopus, Mucor, Entomophthora, Harpella*).
	2. Ascomycota (Ascocarp types, Centrum types, *Protomyces, Taphrina,* yeast,

*Chaetomium, Claviceps, Venturia,* general account of powdery mildews)

**UNIT-III**

1. Comparative study of habit, habitat, somatic organization, anamorph and teleomorph of the member of :
	1. Basidiomycota (*Agraicus, Cyathus, Uromyces, Puccinia, Phragmidium, Ravenelia, Melampsora, Ustilago, Tolyposporium, Urocystis, Neovossia* and *Tilletia*).
	2. Deuteromycota (Sporulating structures, *Fusarium, Curvularia, Colletotrichum, Alternaria, Helminthosporium Cercospora*).
2. Fungi as Mutualistic Symbiots of Photobiots

 Biology of Symbiots, lichen thallus, reproduction and economic importance

5 Compatibility and Alternative genetic systems in fungi

Homothallism, Heterothallism (Sexual incompatibility), Heterokaryosis

 Parasexual cycle

**UNIT IV**

1. Fungi as saprotrophs and their role in nutrient cycling

 Role of decomposers in nature

 Humus formation

 Fungal deterioration of wood

 Economically important timber decay and timber spoilage fungi

1. Fungi in Agriculture

 Fungi as biocontrol agent

 Use of fungi to control weeds (Mycoherbicides) DeVine, Collego,Biomol

 Use of fungi to control plant diseases (Mycofungicides) Rotstop, Soilgard

 Use of fungi to control insect pests (Mycoinsecticides) Green muscle, Boverin

8 Mycorrhiza as a biofertilizer –a brief account

## Suggested Readings:

1. Alexopoulos, C.J. Mins, C.W. & Blackwell, M. 1995: Introductory Mycology, John Willy and Sons. Inc.
2. Bilgrami, K.S. & Dubey H.C. (1986): A text book of Modern Plant Pathology, Vikas, Publ Ltd., N.Delhi.
3. Bilgrami, K.SA. & Verma R.N. (1981): Physiology of fungi, Vikas Publ. Ltd., New Delhi.
4. Biswas, S.P. & Biswas, A. 1984: An Introduction to Viruses, Vani Education Books, New Delhi.
5. Butler, E.J. & Jones, S.G. (1978): Plant Pathology, Periodical Expert Book Agency, New Delhi.
6. Clifton, A. 1958: Introduction to the Bacteria. McGraw Hill Books Co. New York.
7. Mehrotra, R.S. & Aneja, K.R. 1990: An introduction of Mycology, New Age International Press, N.Delhi.
8. Moore-landeckar, E.J. (1972): Fundamentals of the fungi, Prentice Hall, Eaglewood, U.K.
9. Mundukar, B.B. (1967): Fungi & Plant Diseases, Mac million Co. Ltd., USA.
10. Sumbali, G. 2005: The Fungi, Narosa Publ. House, New Delhi.
11. Webster, J. 1985: Introduction of Fungi. Cambridge University, Press.

**Paper – BOT-103 - CYTOGENETICS AND PLANT BREEDING Credit -4 MM-80**

 **Objective:** 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.

**Outcomes:** This paper would help the students to know the role of chromosomes and chromosomal rearrangements in generation of variations. They will also be familiar with methods used to change the traits of a plant 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, CGH and flow cytometery.

**UNIT-II**

5. Chromosome banding techniques: Q-banding; G-banding; R-banding and their uses.

6. Cell cycle: Phases, cell cycle checkpoints and genetic regulation of the cell cycle.

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**  **Credit -4 MM- 80**

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

**Outcomes**: By understanding the concepts of ecological principles and environmental issues, the student will be able to develop attitude, value system and ethics towards environment 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.

 9) Global atmosphere changes: Environmental pollution, global environmental change and its consequences (CO2 fertilization, global warming sea level rise and UV radiation).

10) Biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

**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 - PLANT PATHOLOGY AND MICROBIOLOGY** **Credit -4 MM- 80**

**Objectives:** The course has been conceived to equip students with the knowledge of various diseases caused by different pathogens and their effect on human affairs. In addition the course also deals with growth, culture and maintenance of microbes, their interaction and control by different therapeutic methods.

**Outcome:** After completing the course the students will learn the identification, symptoms, disease cycle and management of different diseases caused by fungi, bacteria, viruses, phytoplasmas etc. The students will understand the microbial interaction, growth and culture of microbes, antimicrobial chemotherapy and environmental microbiology**.**

**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 pathogens, various levels of parasitism, effect of plant pathogens on human affairs, classification of plant diseases.
	2. Casual Organism, symptoms and management of:

 **Diseases caused by Chytridiomycota:**  Wart or black wart disease of potato

 **Diseases caused by Ascomycota:** Powdery mildew of peas, Stem gall of coriander, Apple scab, Blast of rice

 **Diseases caused by Basidiomycota:** Loose smut of wheat, Karnal bunt of wheat, Smut of bajra, Black, yellow and brown rust of wheat, Rust of linseed

 **Diseases caused by Deuteromycota:** Fusarium head blight of wheat, Wilt of pigeon pea, brown leaf spot (Helminthosporiosis) disease of rice, Tikka disease of groundnut, Red rot of sugarcane

 **Diseases caused by** Late and early blight of potato, Downy mildew of grapes, Green ear disease of bajra, white rust of crucifers

## UNIT-II

* 1. Structure, nutrition, reproduction & economic importance of bacteria; classification & general account of Archaebacteria & Eubacteria.

 **Diseases caused by Bacteria:** Bacterial blight of paddy, Crown gall of stone fruits

* 1. Structure & replication of viruses and bacteriophage; transmission & control of viruses; Isolation & purification of Plant Viruses.

 **Diseases caused by Viruses:** TMV, Tristeza of citrus

* 1. Cyanobacteria: Salient features and Biological Importance;
	2. A brief account of phytoplasma

 **Diseases caused by Mollicutes and Phytoplasmas:** Sandal spike

## UNIT-III

 7) **Growth, culture and maintenance of microorganisms**

 Microbial growth and measurement, environmental factors influencing growth.

8) **Control of micro organisms**: Physical methods(High temperature, dry hot or hot air sterilization, moist air sterilization, low temperature, filtration, lycophilisation, Radiation), Chemical methods (Disinfectants and antiseptics)

9) **Microbial interaction**: Functions of symbiotic relationships, types of symbiosis, commensalism, synergism, mutualism-(Lichens, Bacterial endosymbionts of protozoa, Nitrogen fixing symbiosis,mycorrhizae), parasitism.

**UNIT- IV**

10) **Antimicrobial Chemotherapy:**

 Characteristic of anti-microbial drugs, action of antimicrobial drugs, anti bacterial drugs, antifungal drugs, anti viral drugs, Microbial resistance to drugs, Mechanism of drugs resistance

11) **Environmental Microbiology:** Microbiology of fresh, marine and extreme environment,

 Biofilms, Bioremediation of polluted environment, Bioleaching.

## Suggested Readings:

1. Alexopoulos, C.J. Mins, C.W. & Blackwell, M. 1995: Introductory Mycology, John Willy and Sons. Inc.
2. Dubey,H.C. &Bilgrami, K.S. (1986): A text book of Moderm Plant Pathology, Vikas, Publ Ltd., N.Delhi.
3. Bilgrami, K.SA. & Verma R.N. (1981): Physiology of fungi, Vikas Publ. Ltd., New Delhi.
4. Biswas, S.P. & Biswas, A. 1984: An Introduction to Viruses, Vani Education Books, New Delhi.
5. Butler, E.J. & Jones, S.G. (1976): Plant Pathology, Periodical Expert Book Agency, New Delhi.
6. Lee. R.E. (1989): Phycology, Cambridge University Press, U.K.
7. Pelezar, M. J.; Chaing, E.C.S. & Krieg, N.R. 1993: Microbiology. Tata Mc Graw Hill Publ. New Delhi.
8. Mehrotra,R.S. and Aggarwal,Ashok (2003) Plant Pathology, 2nd Edition, Tata McGraw-Hill Publishing company Ltd,New Delhi
9. Mehrotra,R.S. and Aggarwal,Ashok (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd,New Delhi
10. Mundukur, B.B. (1967): Fungi & Plant Diseases, MacMillion Co. Ltd., USA.
11. Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm.C.Brown Publ., USA.
12. Ronald M. Atlas, 1995: Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
13. Moore-landeckar, E.J. (1972): Fundamentals of the fungi, Prentice Hall, Eaglewood, U.K.
14. Singh, R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.
15. Sumbali, G. 2005: The Fungi, Narosa Publ. House, New Delhi.

**Paper – BOT-202 – BRYOPHYTES Credit -4 MM-80**

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

**Outcome:** After studying this paper students will be able to classify bryophytes and distinguish these from other groups of plants. They will also be able to understand origin and evolution of sporophyte in bryophytes.

**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 and Classification up to order level

2. General account of structure and development of gametophyte and sporophyte of

 following orders: Sphaerocarpales (Sphaerocarpos), Calobryales (Calobryum),

Marchantiales (Marchantia, Plagiochasma, Asterella,Targionia, Reboulia) Jungermanniales (Pellia, Porella) and Anthocerotales (Anthoceros, Notothylas)

**UNIT-II**

3. Classification of mosses

4. General account of structure and development of gametophyte and sporophyte of

following orders: Sphagnales, Andreaeales, Takakiales, Funariales (Funaria, Physcomitrium)

and Polytrichales (Polytrichum)

5. Origin and Evolution of spororphyte in bryophytes

**UNIT-III**

6. Cytology of bryophytes: chromosome number, sex chromosome, m chromosomes, accessory chromosomes

7. Experimental studies: Advantages of bryophytes as an experimental system;

8. Morphogenetic studies on spore germination, protonemal differentiation and bud initiation

**UNIT -IV**

9. Biology of reproduction- in vitro regulation of gametangia formation: effect of

physical and chemical factors

10. Economic importance of bryophytes

11. Medicinal uses of bryophytes especially as a source of biologically active compounds

12. Ecological importance of bryophytes: bryophytes as indicators of pollution and minerals; role of bryophytes 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.

**Paper – BOT-203 - Pteridophytes and Gymnosperms Credit -4 MM- 80**

**Objective:** 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.

**Outcome:** After studying this paper students will be able to classify pteridophytes and gymnosperms. They will also be able to describe heterospory, origin of seed habit and evolutionary trends in stele and spore producing organs. Besides above, they will also be able to understand the phenomena of apogamy, apospory and their experimental induction.

**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**

6. General characteristics of pteridophytes and classification

7. Comparative morphology and reproduction of the following:

Psilophytales (Rhynia, Zosterophyllum), Psilotales (Psilotum), Lycopodiales (Lycopodium, Selaginella), Lepidodendrales (Lepidodendron),

Sphenophyllales (Equisetum)

**UNIT-II**

8. Comparative morphology and reproduction of the following :

Ophioglossales(Ophioglossum, Botrychium), Marattiales (Marattia, Angiopteris),

Osmundales, Filicales (Pteris, Dryopteris),Marsileales, Salviniales

**UNIT-III**

1) Classification of gymnosperms and their distribution in India.

2) Brief account of the following families:

Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.

 3) General account of the following orders:

Cycadeoidales(Cycadeoidea), Pentoxylales, Cordiatales

**UNIT-III**

4) Comparative account of Structure and reproduction in the following orders:

Cycadales (Cycas), Ginkgoales (Ginkgo),

Coniferales(Pinus, Cedrus), Ephedrales (Ephedra), Welwitschiales ,

Gnetales

**UNIT-IV**

11)Apogamy, apospory, significance and experimental induction

12)Heterospory and Origin of seed habit in pteridophytes

13)Modern methods of propagation of gymnosperms: somatic embryogenesis, haploids and

protoplast culture

14) Economic importance of gymnosperms

**Suggested Readings:**

1. Parihar, N.S. 1977. The Biology and Morphology of Pteridophytes. Central Book Depot.

Allahabad.

2. Rashid, A. 1976. An Introduction to Pteridophyta (Diversity and Differentiation). Vikas

Publishing House Pvt. Ltd., New Delhi.

3. Sporne, K.R. 1985 (reprint) The Morphology of Pteridophytes. B.I. Publications Pvt. Ltd.,

Delhi.

4. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New

Delhi.

5. Sporne, K.R. 1965. The Morphology of Gymnosperms. B.I. Publications Pvt. Ltd., New

Delhi.

6. Bierhorst, D. W. 1971. Morphology of Vascular Plants. Macmillan. New York.

**Paper – BOT-204 – MOLECULAR GENETICS** **Credit -4 MM- 80**

**Objective:** 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.

**Outcomes:** The students are expected to have better understanding of basic life processes. It will also impart knowledge about the regulation of various 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. 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**

1. Mutations: types, isolation of mutants, molecular basis of mutations.
2. DNA damage and repair: Causes of DNA damage; Photoreactivation, excision, mismatch,

post replication and error prone repair systems.

1. Fine structure of gene: *cis-trans* test, rII locus, fine structure analysis of eukaryotes.
2. Bacterial genetics: conjugation, transduction and transformation.

**UNIT- III**

1. Transcription: Initiation, elongation and termination in prokaryotes and eukaryotes, RNA polymerases.
2. RNA Processing: Processing of mRNA, rRNA and tRNA.
3. Genetic code: Deciphering the genetic code, characteristics.
4. Translation: Initiation, elongation and termination in prokaryotes and eukaryotes; Post- translational modification of proteins.

**UNIT-IV**

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

-Transcriptional level – Regulatory sequences, nucleosome positioning, chromatin remodeling, histone modifications.

-Post-transcriptional level - RNA splicing, RNA stability.

-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-206 -** **PLANTS FOR HUMAN WELFARE CREDIT -2 MM-50**

**Objective:** This course is intended to provide the basic understanding the origin, morphology, cultivation of major crops. It also deals with the traditional knowledge and utility of some common spices, condiments, medicinal plants and horticulture crops.

**Outcomes:** The students are expected to have better understanding of origin of agriculture. They will also be able to identify the plant sources of 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**

**Plants and Civilization:** Origin of agriculture

**Origin crop plants:** Idea about centre of origin of common crop plants

**Major cereals and pulses**

**Spices and condiments (**Saffron, Clove, Cardamom, Ginger, Turmeric, Cinnamon, Capsicums, Asafetida, Coriander, Fennel, Fenugreek**)**

**UNIT -II**

**Medicinal plants:** Importance of medicinal plants – role in human health care

**Traditional knowledge and utility of some common medicinal plants-***Sarpgandha, Isabgol,Vasaka, Neem, Bhiringraj, Amla, Harrad, Bahera, Arjun ,Punarnava , Brahmi, Kasondi, Ghritkumari, Quinine and Eucalyptus*

**Hallucinogenic plants – general account**

**UNIT -III**

**Nutritive and medicinal value of some fruits** **and vegetables** (Guava, Sapota, Orange,

Mango, Banana, Lemon, Pomegranate, Moringa, Cabbage)

**Beverages** (Coffee, Tea, Chocolate, Cola)

**Common ornamental plants**

**Common food adultrants**

**UNIT-IV**

**Common timber yielding plants and minor forest products**

**General account of Fibers, dyes, tannins, gums and resins**

**Insecticides from plants (**Pyrethrum**)**

**Suggested Readings:**

Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.

Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.

Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.

Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.

SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi

Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA

Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.

**SEMESTER – III**

**Paper – BOT-301 Plant Physiology and Plant Biochemistry Credit -4 MM-80**

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

**Outcome:** The students will be able to understand the physiology and basic metabolism of plants. They will able to answer the questions regarding water transport, absorption, mineral nutrition, photosynthesis, respiration 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:**

Bonner, J. and Varner, J.E. (1976). Plant Biochemistry, IIIrd Edition, Academic Press, New York and London.

Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd

Edition. Kluwer Academic Publishers, The Netherlands.

Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.

Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.

Hopkins, W.G. (1995) Introduction to Plant Physiology, John Wiley and Sons.

Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.

Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East-West Press Pvt Ltd. New Delhi.

Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India (Indian edition).

Lehninger, A.L, Nelson, D.L. and Co MM 1993Principles of Biochemistry Second edition, CBS Publishers.

Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi..

Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology, Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.

Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, Wadsworth Publishing Co. Belmont, California, USA.

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.

Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.

Taiz, L and Zeiger, E. (1998). Plant Physiology. Second edition. Sinauer Associates, Inc., Publishers, Massachusetts, USA

Trehan, K. (1990). Biochemistry. Second edition, Wiley-Eastern Ltd., New Delhi.

Trivedi, P.C. (2006). Plant Molecular Physiology: Current Scenario and Future Projections. Aavishkar Publishers, Distributors, Jaipur.

Weil, J.H. (1990). General Biochemistry. Sixth edition. Wiley-Eastern, New Age International Publishers, New Delhi.

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 Credit -4 MM-100**

**Objective:** 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.

**Outcome:** The students will be able to understand the different systems of classification of angiosperms. They will also be able to identify the plant sources of 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.

Botanical Gardens and herbaria in India; Botanical Survey of India its organization and role.

**UNIT-II**

Salient Features of the International Code of Botanical Nomenclature.

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:**

Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc.

Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan C., New York.

Davis, P.H. and Heywood, V.H. 1965. Principles of Angiosperm Taxonomy. D Van Nostrand Co. , New York.

Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., New Delhi.

Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.

Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.

Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.

Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.

SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi

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.

Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA

Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.

Hancock. J. F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing, Cambridge, MA USA.

Radford, A. E., W. C. Dickison, J. R. Massey, C. R. Bell. 1976. Vascular Plant Systematics Harper and Row, New York.

**Paper – BOT-303 Biotechnology and Genetic Engineering Credit -4 MM-80**

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

**Outcomes:** The students will have better understanding of genetic engenniering, PCR, genetic transformation and transgenic 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**

Techniques used in DNA Technology: Gel Electrophoresis, PFGE, Southern and Western blotting, Dot blots, slot blots, DNA chip technology; Brief account of genomics and Proteomics.

Isolation of genes, Sequencing of genes; Maxam & Gilberts method, Sanger’s method, Automatic Sequencers, synthesis of genes: chemical synthesis, Gene synthesizing machines.

**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: labeling 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**

Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-44- Transgenenic Trees, Springer Pub., New York, USA

Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-46-Transgenic Trees, Springer Pub., New York, USA

Brown, T.A. 1999 Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore

Dawson, M.T. Powell, R, and L. Gannon, F.1996. Gene Technology, BIOS Sci. Pub. Ltd., Oxford, UK.

Erlich, H.A.(Ed.) 1989, PCR Technology – Principles and applications for DNA Amplification, Stockton Press, New York, USA

Glazer, A.N. and Nikaido, H. 1995. Microbial Biotechnology, W.H. Freeman & Company, New York, USA

Glover, D.M. and Hames, B.D.(Eds.) 1995. DNA Clonning 1 – A Practical Approach, OIRL Press, Oxford, UK

Gupta, P.K. 1996. Elements of Biotechnology, Rastogi & Co., Pub., New Pub., Meerut, India.

Hammond, J., McGarvey, P. and Yusibov, V. (Eds.) 1999. Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.

Henry, R.J. 1998. Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK

Keller, G.H. and Manak, M.M. 1993. DNA Probes, Mac Millan Pub. Ltd. UK.

Lea, P. and Leegood, R.C. 1999. Plant Biotechnology and Molecular Biology (2nd Ed.) John Wiley & Sons, Ltd., England.

Lewin, B. 2005. Genes VIII,Osford University Press, Oxford, UK

Lindsey, K. and Jones, M.G.K. 1990. Plant Biotechnology in Agriculture, Prentice Hall Int. Pub., London, UK

Malaacinski, G.M. and Freifilder, D. 1998. Essentials of Molecular Biology 3rd Ed.), Jones & Bartlett Pub., London, UK

Miesfield, R.L. 1999. Applied Molecular Genetics, Wiely Liss, New York, USA.

Nicklin,J., Graeme-Cook, K.Paget, T. and Killington, R. 1999. Instant Notes in Mircobiology, VIVA Books Pvt. Ltd., New Delhi, India

Purohit, S.S., Kothari, P.R. and Mathur, S.K. 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. Bikaner, India.

Rehm;, H.I. and Reed, S.G. (Eds.) 1995. Fundamentals of Genetic Engineering, Pallicut, London, UK.

Scragg, A. 1999. Environmental Biotechnology, Pearson Education Ltd., England, UK

Shantharam, S. and Montogomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Pub. Pvt. Ltd., New Delhi, India.

Sheehan, D. (Ed.) 1997. Bioremediation Protocols, Humana Press, Totowa, USA

Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Ed.) John Wiley & Sons. Inc., New York, USA

Trehan, K. 1990. Biotechnology, New Age INt. Pvt. Ltrd. New Delhi India.

Twyman, R.M. 1999. Advanced Molecular Biology, VIVA Books Pvt. Ltd., New Delhi, India.

**Paper – BOT-304(a) - ADVANCED PHYCOLOGY (ELECTIVE) Credit -4 MM-80**

**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.

**Outcome:** 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.

**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 N2-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

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.

9. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing

**Paper – BOT-304(b) - APPLIED MYCOLOGY (ELECTIVE) Credit -4 MM-80**

**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**.**

**Outcome:** After successfully completing the course, the students will understand the role of fungi as biofertilizers, as food spoilers and in production of some industrially important products. The students will also learn the various techniques used for culturing of fungi, sterilization of media and maintenance of cultures.

**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:**

Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.

Bilgrami, K.SA. & Verma R.N. (1981): Physiology of fungi, Vikas Publ. Ltd., New Delhi.

Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.

Butler, E.J. & Jones, S.G. (1976): Plant Pathology, Periodical Expert Book Agency, New Delhi.

Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.

Dubey, R.C. (2005): A Text Book of Biotechnology, S Chand & Co. Ltd., New Delhi.

Bilgrami, K.S. & Dubey H.C. (1986): A text book of Modern Plant Pathology, Vikas, Publ. Ltd., N.Delhi.

Gupta, R. & Mukerji, K.G. (2001): Microbial Technology, APH Publ. Co., New Delhi.

Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, N. Delhi.

Michael J. Pelezar, E.C.S. Chaing & N.R. Krieg, 1993: Microbiology. Tata McGraw Hill Publ. N. Delhi.

Mundukur, B.B. (1967): Fungi & Plant Diseases, Pochillion Co. Ltd., USA.

Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm. C. Brown Publ., USA.

Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.

Moore-landeckar, E.J. (1972): Fundamentals of the fungi, Prentice Hall, Eaglewood, U.K.

Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.

**Paper – BOT-304(c) - RESTORATION ECOLOGY** **(ELECTIVE) Credit -4 MM-80**

**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.

**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.

**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.

**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) Credit-4 MM-80**

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

**Outcome:** The students will be able to understand the physiological advances in response of plants to water, salt and temperature stress. They will also be acquainted with advances in photosynthesis and 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.

 Water stress:

**UNIT-I**

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.

 Salt and temperature stress:

**UNIT-II**

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.

Photosynthesis:

**UNIT-III**

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:

Bonner, J. and Varner, J.E. (1976) Plant Biochemistry, Academic Press, New York and London (Third Edition).

Buchanan, B.B., Gruissem, w. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Cooper, T.G. (1977). Electrophoresis. In : The Tools of Biochemistry. John Wiley and Sons., New York.

Dey, P.M. and Harborne, J.B. (1997), First Indian edition, 2000). Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.

Noggle, G.r. and Fritz, G.J. (1983). Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition (Seventh reprint, 1992).

Salisbury, F.B. and Ross, G.W. (1992). Plant Physiology. Fourth Edition, Wadsworth Publishing Co. Belmont, California, USA.

Sawhney, S.K. and Singh, Randhir. (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.

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) Credit -4 MM-80**

**Objective:** 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.

**Outcomes:** This paper is meant for students to gain in-depth knowledge of various methods used in characterization the biomolecules.

**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 tunnelling 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

1. **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.
2. **Spectrophotometery**: Colorimetery; UV and Visible spectrophotometery.

UNIT-III

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

UNIT-IV

1. **Immunotechniques**:Antibody generation; Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells.
2. **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-306 – Biodiversity and its conservation Credit -2 MM-50**

**Objectives:** This paper is meant for students to gain in-depth knowledge of different levels, threats and distribution of Biodiversity and focus on the different approaches for biodiversity conservation.

**Outcomes:** The student will be able to appreciate the value of biodiversity. They will also develop the skills necessary to work efficiently in areas of *in-situ* and *ex-situ* conservation.

**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. Biodiversity: importance, levels of biodiversity- species, genetic and ecosystem diversity, threats to biodiversity- habitat loss and fragmentation, exotic species, pollution, overexploitation, IUCN categories of threat
2. Distribution and global patterns of biodiversity
3. Biodiversity and ecosystem services
4. Terrestrial and marine hotspots of biodiversity; hotspots of biodiversity in India.

UNIT-II

1. Principles and importance of conservation biology; In- situ conservation of biodiversity-Sanctuaries, national parks, biosphere reserves.
2. Ex-situ conservation of biodiversity: Principles and practices, field gene banks, seed banks and cryopreservation
3. Approaches for biodiversity conservation: tropical forests, wetlands and aquatic ecosystems
4. Major approaches to Management, Indian case studies on conservation/management strategy (Project tiger, biosphere reserves)

**Suggested Readings :**

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

Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk bv. The Hague.

Heywood, V.(Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.

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.

Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley

& Sons Inc., New York.

Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.

Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

**SEMESTER – IV**

**Paper – BOT-401 PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT Credit-4 MM- 80**

**Objective:** 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.

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

**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:**

Audus, L.J. (1972). Plant Growth Substances. Vol.I Chemistry and Physiology. Leonard Hill, London.

Bonner, J. and Varner, J.E. (1976). Plant Biochemistry,IIIrd Edition, Academic Press, New York and London.

Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemstry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.

Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt.Ltd.

Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.

Hopkins, W.G. 1995 Introduction to Plant Physiology, John Wiley and Sons.

Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.

Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East- West Press Pvt Ltd. New Delhi.

Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India

Lehninger, A.L, Nelson, D.L. and Co MM 1993 Principles of Biochemistry Second edition, CBS Publishers.

Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi..

Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology, Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.

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

Trehan, K. (1990). Biochemistry. Second edition, Wiley-Eastern Ltd., New Delhi.

Trivedi, P.C. (2005). Applied Botany. Aavishkar Publishers, Distributors, Jaipur.

Trivedi, P.C. (2006). Plant Molecular Physiology: Current Scenario and Future Projections. Aavishkar Publishers, Distributors, Jaipur.

Weil, J.H. (1990). General Biochemistry. Sixth edition. Wiley-Eastern, New Age International Publishers, New Delhi.

Wilkins, M.B. (1987). Advanced Plant Physiology, ELBS, Longman, England.

Zubay, Geoffrey. (1989). Biochemistry. Mc.Millan Publishing Co. New York.

**Paper – BOT-402 Biology of Reproduction and Anatomy Credit -4 MM-80**

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

**Outcome:** The students will be able to describe the structure and development of reproductive structures and the process of reproduction 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; apomixis

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:

Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.

Shivanna, K.R. and Johri, B.M. 1985. The Angiopsrem Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi.

Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge Univ. Press, Cambridge.

Johri, B.M. (ed.) Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin,

Esau, K. 1965. Plant Anatomy. John Wiley & Sons New York.

Fahn, A. 1967.Plant Anatomy. Pergamon Press, London, New York.

Eames , A.J. and MacDaniels, L.H. 1947. An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New York.

Eames, A. J. 1961. Morphology of Angiosperms. McGraw Hill Book Company, New York

**Paper – BOT-403 Plant Tissue Culture Credit -4 MM-80**

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

**Outcomes:** The students will gain in-depth knowledge of plant cell and tissue culture techniques, In vitro haploid production, plant breeding, synthetic seeds and secondary metabolite production.

**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 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.

Protoplast isolation, fusion and culture, somatic hybridization, hybrid selection and regeneration. Cybrids and their application.

**UNIT-II**

In vitro haploid production and its significance, Anther/Pollen culture and ovary culture; Embryo and ovule culture for wide hybridization.

Micropropagation: meristem culture and virus-free plants; Cryopreservation of plant cell and tissue cultures and establishment of gene banks.

**UNIT-III**

Somaclonal variations in plant cell cultures; mechanisms and applications in genotype improvement.

Role of plant cell cultures in clonal mass multiplication, plant breeding and secondary metabolite production.

**UNIT-IV**

Somatic embryogenesis, production of synthetic seeds, importance, limitation and their utilization.

Application of tissue culture in forestry and agriculture; status of tissue and cell culture technology in India.

Suggested Readings

Bhojwani, S.S. and Razadan, M.K. 1996. Plant Tissue Culture: Theory and Practice ( A revised Edition), Elsevier Science Pub., New York, USA

Collins, H.A. and Edwards, S. 1998, Plant Cell Culture, Bios Scientific Pub., Oxford, U.K.

Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs, CRC Press, Boca Raton, Florida, U.S.A.

Razadan, M.K. 1993. An introduction to Plant Culture. Oxford & IBH Pub., Co., New Delhi, India

Yeoman, M.N. (Ed.) 1987. Plant Cell Culture Technology, Narosa Publ.,New Delhi, India

**Paper – BOT-404(a) ADVANCED PHYCOLOGY (ELECTIVE) Credit -4 MM-80**

**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.

**Outcome:** To nurture and develop the trained human resources/ professionals to identify research problems, formulate testable objectives, develop appropriate methods & experimental designs, implement research projects in wider perspective of alagalization.

**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 CO2-assimilation with nitrogen assimilation: source of energy & reductants.

3. Nutrient uptake kinetics in algae.

**UNIT-II**

4) Importance of N2-fixing genera in Indian paddy fields for the improvement of soil fertility.

5) Heterocyst, its differentiation and role in N2-fixation.

6) Mechanism N2-fixing fixation: nitrogenase 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) Credit -4 MM-80**

**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.

**Outcome:** The students will understand various mechanisms involved during pathogenesis and disease epidemiology, plant disease forecasting and transmission and spread of plant pathogens. The students will learn the applications of biotechnological techniques in plant pathology after completing the course.

**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:**

Agrios, G.N. (2005): Plant Pathology, Acad. Press, Inc. California.

Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.

Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.

Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.

Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, New Delhi.

Mehrotra, R.S. and Ashok Aggarwal (2003): Plant Pathology, Tata Mc Graw Hill Publ. Ltd., New Delhi.

Michael J. Pelezar, E.C.S. Shan & N.R. Krieg (1993): Microbiology. Tata Mc Graw Hill Publ. New Delhi.

Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.

Singh, R.S. (1990): Plant Disease, 6th Edition, Oxford, IBH Publ., New Delhi.

Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.

Webster, J. (1985): Introduction of Fungi. Cambridge University, Press.

**Paper – BOT-404(c) CONSERVATION BIOLOGY** **(ELECTIVE) Credi-4 MM-80**

**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.

**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.

**Outcomes:** Student will develop the skills necessary to work efficiently in areas like conservation, EIA, environment management, monitoring and education and also gets an objective, scientific and realistic approach to conservation science.

**UNIT-1**

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

**UNIT-2**

1. Global biodiversity I: Patterns and Processes
2. Global biodiversity II: Losses, Pattern of species vulnerability, Habitat fragmentation and degradation, Synergistic interactions
3. Biodiversity and ecosystem services

**UNIT-3**

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

**UNIT-4**

1. Importance of genetic resources and conservation of crop genetic resources
2. International and National efforts to conserve biodiversity: Convention on biological diversity, CITES, Ramsar convention; National Biodiversity strategy
3. Role of remote sensing and GIS and biodiversity conservation

**Suggested Readings :**

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

Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk bv. The Hague.

Heywood, V.(Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.

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.

Huston, M.A. 1994. Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.

Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley

& Sons Inc., New York.

Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.

Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

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) Credit -4 MM-80**

**Objective:** 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.

**Outcome:** The students will be able to understand the recent advances in phytohormones, fruit and seed physiology. They will also be acquinted with advances in senescence and abscission also.

**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.

Phytohormones

**UNIT-I**

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:

Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.

Khan, A.A (1977). The Physiology and Biochemistry of Seed Dormancy and germination. North-Holland Publishing Co., Amsterdam, New Oxford.

Moore. T.C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi.

Saymour, G.B., Taylor, J.E. and Tucker, G.A. (1993). Biochemistry of Fruit Ripening. Chapman and Hall, London.

Stahl, E. (1965). Thin Layer Chromatography, a laboratory handbook. Academic Press, London.

Taiz, L. and Zeiger, E. (1998). Plant Physiology. Second edition, Sinauer Associates, Inc., Publishers, Massachusetts, USA.

Wilkins, M.B. (1987). Advanced Plant Physiology. ELBS-Longman, England.

Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.

Trivedi, P.C. (2005). Applied Botany. Aavishkar Publishers, Distributors, Jaipur.

**Paper – BOT-404(e) GENOMICS** (**ELECTIVE) Credit -4 MM-80**

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

**Outcomes:** This paper would provide students an understanding about how the genetic information is stored in the genome and the mechanisms by which this information is used by the organism. They are also expected to know about the various databases used for storage and analysis of genome information.

**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 (T4, 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

1. **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.
2. **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

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

UNIT-IV

1. **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.
2. **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.