Master of Science in Botany

PROGRAMME STRUCTURE AND SYLLABUS
2019-20 ADMISSIONS ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

BOARD OF STUDIES IN BOTANY (PG)
MAHATMA GANDHI UNIVERSITY

2019

THE BOARD OF STUDIES IN BOTANY (PG)

Chairperson:
Dr. David Saj Mathew,
Associate Professor and Head.
Union Christian College, Aluva.

Members:

1.Dr. Elizabeth Thomas
Associate Professor,
St. Thomas College, Kozhencherry

2. Dr. S.V. Pradeep
Associate Professor,
SVR NSS College, Vazhoor

3. Shri. Paul Karamthanam
Associate Professor,
St. Thomas College, Pala.

4. Dr. S. Subramanyan
Associate Professor,
University College, Thiruvanathapuram

5. Shri. Thomas Antony
Assistant Professor
Maharaja's College, Ernakulam.

6. Smt. Jincy P. Abraham
Assistant Professor
Mar Thoma College, Thiruvalla.

7. Dr. Benoj Mathew
Assistant Professor
St Peter's College, Kolencherry.

8. Dr. Sanilkumar M.G.
Assistant Professor
S.N.M. College, Maliankara.

9. Dr. Hari N.
Assistant Professor
CMS College, Kottayam.

10. Dr. Laija S. Nair
Assistant Professor
University College, Thiruvanathapuram

CONTENTS **Pages**

Objectives and Programme outcome

M.Sc. Botany Programme is a two-year post-graduate programme, which deals with basic and advanced study on plants. It is one of the multi-disciplinary fields with great demand in various fields of research and development. The programme envisages developing understanding and knowledge for applying into sectors like agriculture, horticulture, floriculture, biotechnology, genomics, forest and environment. The programme is divided across 4 semesters of 90 days each.

These are exciting times in Biology. The world of Biology has been transformed in the last few decades. There was too much to select from. However, the Board of studies designed the programme envisioning the following objectives:

- To encourage a clear, comprehensive and advanced mastery in the field of Botany.
- To provide basic principles of biological sciences with special reference to Botany and itsapplied branches.
- Enabling the students to explore the intricacies of life forms at cellular, molecular and Nano level.
- To sustain students' motivation and enthusiasm and to help them not only to appreciate the beauty of different life forms but also to inspire them in the dissemination of the concept of biodiversity conservation.
- To develop problem solving skills in students and encourage them to carry out innovativeresearch projects thereby enkindling in them the spirit of knowledge creation.
- To maintain a high level of scientific excellence in botanical research with added emphasis on the role of plants in the structure and functioning of terrestrial and aquatic communities and ecosystem
- To equip students to perform functions that demand higher competence in National/International fields.

THE PROGRAM STRUCTURE

Course code	Title of the course	Teaching hours		Credits
		Theory	Practical	
SEMESTER I				
BY010101	Microbiology	27	9	4
	Phycology	45	36	
BY010102	Mycology	36	36	4
	Crop pathology	36	18	
BY010103	Bryophytes	36	18	4
	Pteridophytes	36	36	
BY010104	Gymnosperms and Paleobotany	36	27	3
	Evolution	18	--	
BY010105	Microbiology, Phycology, Mycology and Crop Pathology Practical			2
BY010106	Bryology, Pteridology, Gymnosperms, and Paleobotany Practical			2
Total		**270**	**180**	**19**
SEMESTER II				
BY010201	Anatomy	36	27	4
	Developmental Biology	18	9	
	Horticulture	18	9	
BY010202	Cell Biology	27	18	4
	Genetics	27	18	
	Plant Breeding	18	9	
BY010203	Plant Physiology	45	36	4
	Biochemistry	27	27	
BY010204	Molecular Biology	54	18	3
BY010205	Anatomy, Developmental Biology, Horticulture, Cell biology, Genetics and Plant breeding Practical			2
BY010206	Plant Physiology, Biochemistry and Molecular biology Practical			2
Total		**270**	**180**	**19**
SEMESTER III				
BY010301	Research Methodology	18	9	4
	Micro-technique	18	27	
	Biostatistics	18	9	
	Biophysical Instrumentation	18	18	
BY010302	Biotechnology, Bioinformatics and Bio-nanotechnology	72	36	4
BY010303	Angiosperm Taxonomy, Economic Botany and Ethanobotany	72	63	4
BY010304	Environmental Science	54	18	3
BY010305	Research Methodology Micro technique, Biostatistics, Biophysics and Biotechnology and Bioinformatics Practical			2
BY010306	Angiosperm Taxonomy, Economic Botany and EnvironmentalScience Practical			2
Total		**270**	**180**	**19**

SEMESTER IV				
BY800401	Elective course IBiotechnology - Plant tissue Culture and Microbial Biotechnology	90	72	4
BY800402	Elective course IBiotechnology – Genetic Engineering, Genomics and Immunology	90	54	4
BY800403	Elective course IBiotechnology – Genomics, Transcriptomics, Proteomics and Bioinformatics	90	54	4
BY800404	Elective course IBiotechnology- Practical Paper I Plant Tissue Culture and Microbial Biotechnology			2
BY800405	Elective course IBiotechnology- Practical Paper II Genetic Engineering, Genome Editing, Immunology, Genomics, Transcriptomics, Proteomics and Bioinformatics			2
BY810401	Elective course IIMicrobiology- Food, Agricultural and Environmental Microbiology	90	72	4
BY810402	Elective course IIMicrobiology – Clinical Microbiology	90	54	4
BY810403	Elective course IIMicrobiology – Industrial Microbiology	90	54	4
BY810404	Elective course IIMicrobiology- Practical paper I Food, Agricultural and Environmental Microbiology			2
BY810405	Elective course IIMicrobiology- Practical paper II Clinical Microbiology and Industrial Microbiology			2
BY820401	Elective course III Environmental Science – Basic Concepts in Environmental Studies	90	72	4
BY820402	Elective course III Environmental Science –Natural Resources and their management	90	54	4
BY820403	Elective course III Environmental Science – Environmental Monitoring and Management	90	54	4
BY820404	Elective course III Environmental Science – Practical paper I Basic Concepts in Environmental Studies			2
BY820405	Elective course III Environmental Science – Practical paper II Environmental Science –Environmental Monitoring and Management, Environmental Monitoring and Management	/		2
	Project work			4
	Viva-voce			3
Total		**270**	**180**	**23**

SEMESTER I

FIRST SEMESTER COURSES

BY010101	MICROBIOLOGY AND PHYCOLOGY
BY010102	MYCOLOGY AND CROP PATHOLOGY
BY010103	BRYOLOGY AND PTERIDOLOGY
BY010104	GYMNOSPERMS, PALEOBOTANY AND EVOLUTION
BY010105	MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND CROP PATHOLOGY- PRACTICAL
BY010106	BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, AND PALEOBOTANY - PRACTICAL

Total Credits: 19
Total Hours: 450

BY010101: Microbiology and Phycology
(Theory 27+45=72 Hrs; Practical 9+36=45Hrs)Credits4

MICROBIOLOGY (27 hrs)

Module 1: Introduction to microbiology (2 hrs)

Milestones in Microbiology, Microbial taxonomy and phylogeny - Major groups and their characteristics (Fivekingdom system and three domain system of classification).

Module 2: Bacteria (7 hrs)

Bacterial morphology. Classification of Bacteria according to Bergey's manual of systematic bacteriology (Brief study up to family). Ultra structure of Gram positive and Gram negative bacteria; cell membrane, cell wall, flagella, pili, fimbriae, capsule and slime, ribosome and endospores. Major groups of Bacteria: Nanobes, VBNC, Spirochetes, Rickettsias, Chlamydias, Mycoplasmas, Actinomycetes, Myxobacteria, Archaebacteria (general account only). Extremophiles - thermophilic, halophilic, acidophilic and alkalophilic bacteria. Nutritional types, Bacterial genome chromosome, plasmids-types of plasmids-R plasmids, Col plasmids and F plasmids

Module 3: Bacterial systematics (4 hrs)

Systematic identification of bacteria: Phenotypic-Morphology, Motility, Colony characters, Biochemical tests (Tests for carbohydrates, proteins and enzymes). Molecular techniques for the identification of bacteria-16SrRNA sequencing. A brief account on metagenome analysis for the identification of non-culturable microbes.

Module 4: Culture of microorganisms (4 hrs)

Sterilization techniques in microbiology-physical and chemical methods(Physical-dry heat and moist heat, radiation, filter sterilization; Chemical-commonly used surface sterilant), Disinfection;Methods of isolation of pure cultures. Types of culture media. Enrichment culture techniques. Maintenance and preservation of pure cultures.

Module 5: Plant–Microbe interactions (2 hours)

Brief study on endophytes- bacteria and fungi, their role in plant growth promotion and secondary metabolite production.

Module 6: Viruses (8 hrs)

Nomenclature and classification-types of viruses-DNA and RNA Viruses, properties of viruses, morphology (symmetry) of viruses; Capsid and their arrangements; types of envelops and their composition, Viral genome. Structure of bacteriophages belonging to 'T' series- ultra structure of TMV. Viral replication: Lytic and Lysogenic cycles - Lytic cycle in T even phages, and lysogeny in lambda phage. Sub viral particles - prions, viroids, virusoids (brief description only).

Practical (9 hrs)

1. Preparation and sterilization of microbial culture media -Nutrient broth and nutrient agar
2. Inoculation of bacteria-stabbing and streaking
3. Differential staining of bacteria using Gram stain.
4. Endospore staining
5. Isolation of Rhizobium from root nodules.
6. Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.
7. Streak out a bacterial culture on an agar plate and isolation of colonies –Quadrant streaking method
8. Antibacterial assay - disc diffusion/agar well method.

References

1. Ananthanarayan and Panicker. Text Book of Microbiology, Sterling Publications
2. Bilgrami, Sinha. *Essentials of Microbiology*.
3. Carpenter P L (1967). *Microbiology*. W B Saunder & Co. Philadelphia.
4. Dube H C (2008). *Fungi, Bacteria and Viruses*. Agrobios.
5. Kanika Sharma (2005). *Manual of Microbiology: Tools and Techniques*. Ane Books.
6. Kumar H D (1990). *Modern concepts of Microbiology*. Vikas public. Delhi.
7. Lansing M Prescott, Harley, Klein (1999). *Microbiology*.
8. Monica Cheesbrough. Medical Laboratory Manual for tropical countries. Elsevier, London, UK.
9. Pelczar Michael J, Adams M R, Chan E C S, Krieg Noel R (2000). *Microbiology*. Tata McGraw Hill.
10. Pelczar (1990). *Microbiology*. T M H.
11. Purohit S S (1997). *Microbiology: Fundamentals and application*. Agrobotanical.
12. Powar C B, Daginawala H F (1991). *General Microbiology* Vol II. Himalaya Publishing House.
13. Willey, Presscot's Microbiology IXth Edition
14. Salle A J (1978). *Fundamentals of Bacteriology*. Asia TMH
15. Dubey R C, Maheswari D K (2004). *Microbiology*. S Chand.
16. Sharma P D (2003). *Microbiology*. Restogi pub.
17. F H Kayser, K A Bienz, J Eckert, R M Zinkernagel. *Medical Microbiology.*
18. L R Haahelm, J R Pattison, R J Whitley. *Clinical virology.*
19. Thandavarayan Ramamurthy, Amit Ghosh, Gururaja P. Pazhani, and Sumio Shinoda·Current Perspectives on Viable but Non-Culturable (VBNC) Pathogenic Bacteria. Frontiers in Public Health, 2014; 2: 103.
20. Nanobes and Nanobacteria -SERC. https://serc.carleton.edu/microbelife/ topics/nanobes /index.html

Phycology (45 hrs)

Module 1: Introduction (4 hrs)

History of algal classification. Detailed study of the classification by F. E. Fritsch. Brief account on the classification (Upto groups and divisions) by Edward Lee (2008). Gene sequencing and algal systematics (Brief study only). Centers of algal research in India. Contributions of Indian phycologists – M O P Iyengar, GS Venkataraman, T V Desikachary.

Module 2: General features of Algae (27 hrs)

Habit, habitat and distribution of Algae. Major characteristics of Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae and Rhodophyceae. Range of thallus structure. Algal components: Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products. Reproduction in algae: Vegetative, asexual and sexual reproduction (development of sex organs not necessary). Major patterns of life cycles in algae and post fertilization stages in Phaeophyceae and Rhodophyceae. Algae and fossil records, special reference to India; a short description on *Rafatazmia chitrakootensis*

Module 3: Ecological and Economic importance of Algae (9 hrs)

Ecological importance of Algae. Primary productivity. Algae in symbiotic association, Ultraviolet radiation absorption by algae. Algae as food, fodder, biofertilizer, medicine, industrial uses and other useful. Algae in experimental studies. (SCP, Biofuel, Live feeds, EPS). Chemically mediated interactions in microalgae: Allelopathy (brief account only). Harmful effects of algae: Algal blooms, causative organisms, symptoms and toxins of major toxic algal blooms (Amnesic Shellfish Poisoning [ASP], Paralytic Shellfish Poisoning [PSP] and Cyanophycean toxins).

Module 4: Algal biotechnology (5 hrs)

Methods and techniques of collection, preservation and staining of Algae. Algal culture:Importance, methods; Algal culture media (Walne's medium)

Practical (36 hrs)

1. Critical study of diagnostic features and identification of the following genera based onmorphological, anatomical and reproductive parts;

(a) Cyanophyceae - *Gleotrichia, Spirulina, Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema*.

(b) Chlorophyceae - *Chlamydomonas, Volvox, Ecballocystopsis, Ulothrix, Microspora, Ulva,Cladophora, Pithophora. Coleochaeta, Chaetophora, Drapernaldia, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium, Desmedium, Bryopsis, Acetabularia, Codium, Caulerpa, Halimeda, Chara, Nitella*.

(c) Xanthophyceae – *Vaucheria*.

(d) Bacillariophyceae –O*dontella, Navicula*.

(e) Phaeophyceae - *Ectocarpus, Colpomenia, Hydroclathrus, Dictyota, Padina, Sargassum, Turbinaria*.

(f) Rhodophyceac - *Brtrachospermum, Gelidium, Amphiroa, Gracilaria, Polysiphonia*.

2. Students are to collect and identify algae from different habitat. Prepare and submit a report of the field work with sufficient photographs of algal collection.

References

1. Andersen R A (Ed) 2004. *Algal Culturing Techniques*, Elsevier.
2. Bellinger E.G Sigee D C. (2015*). Freshwater Algae Identification, Enumeration and use as Bioindicators.* John Wiley and Sons Ltd.
3. Bold H C, Wynne M J (1978). *Introduction to Algae: Structure and reproduction*. Prentice Hall.
4. Borowitzka M A, Beardall J, Raven J H (2016). The physiology of microalgae. Springer.
5. Chapman V J (1962). *The Algae*. Macmillan & Co. Ltd.
6. D'Silva M.S, Anil, A C Naik R K, D'Costa P M (2012). *Algal blooms: a perspective from the coasts of India. Nat Hazards,* 63:1225–1253 DOI 10.1007/s11069-012-0190-9
7. Das S K, Adhikary S B (2014). *Freshwater Algae of Eastern India*. Astral Inernational
8. Desikachary, T.V. 1959. *Cyanophyta.* Indian Council of Agricultural Research.
9. Fritsch F E (Vol. I, II) (1977). *The structure and reproduction of Algae*. Cambridge University Press.
10. Hallegraeff, G.M, Anderson D.M, Cembella A D (2004). *Manual on Harmful Marine Microalgae* UNESCO.
11. ICAR Publications: *Algal monographs*
12. Jha B, Reddy C R K, Rao M R (2009). Seaweeds of India: The diversity and distribution of seaweeds of Gujarat coast. Springer.
13. Kundal P, Mude S M (2009). *Geniculate coralline algae from the Neogene-quaternary sediments in and around Porbandar, southwest coast of India*. Journal geological society of India 74:267-274.
14. Kundal P, Mude S M (2012). *Additional coralline algae from the lower Miocene to late Holocene sediments of the Porbandar group, Gujarat*. Journal geological society of India 79:69-76.
15. Lee R E (2012). *Phycology* 4th edition. Cambridge University Press.
16. Perumal S, Thirunavukkarasu A R, Pachiappan P (2015), *Advances in marine and brackish water aquaculture,* Springer
17. Reynolds C S (2006). Ecology of phytoplankton, Cambridge University Press
18. Richardson, K. (1997). Harmful or exceptional phytoplankton blooms in the marine ecosystems. In. Blaxter and Southward (Eds) *Advances in Marine Biology,* 31:301-385. Academic Press
19. Smith G M (1971). *Cryptogamic Botany (Vol. 1): Algae and Fungi*. Tata McGraw Hill Edition.
20. Tomas, C.R. 1997 *Identifying Marine Phytoplankton*. Academic press.
21. Bengtson S Sallstedt T Belivanova V Whitehouse M (2017). *Three-dimensional preservation of cellular and sub cellular structure suggest 1.6 billion year old crown group red algae,* PLOS Biology, DOI: 10.1371/journal.pbio.2000735, March 14.

BY010102 MYCOLOGY AND CROP PATHOLOGY

(Theory 36 + 36 = 72 Hrs; Practical 36 + 18 = 56 Hrs) Credits 4

MYCOLOGY (36 hrs)

Module 1: General introduction (2 hrs)

General characters of Fungi and their significance. Principles of classification of fungi, Classifications by C J Alexopoulos and Mims(1979)

Module 2: Thallus structure and reproduction in Fungi (27 hrs)

Mycelial structure and reproduction of Myxomycota – Acrasiomycetes,(Brief introduction only)Hydromyxomycetes, (Brief introduction only) Myxomycetes, Plasmodiophoromycetes. Mastigomycotina - Chytridiomycetes, (Brief introduction only) Hyphochytridiomycetes(Brief introduction only) Oomycetes. Zygomycotina - Zygomycetes, Trichomycetes. Ascomycotina - Hemiascomycetes, Pyrenomycetes, Plectomycetes, Discomycetes, Laboulbeniomycetes, Loculoascomycetes. Basidiomycotina - Teliomycetes, Hyphomycetes, Gastromycetes. Deuteromycotina - Blastomycetes, Hyphomycetes, Coelomycetes. Types of fruiting bodies in fungi.

Module 3: Fungal associations and Fungal Physiology (5 hrs)

Symbionts - Lichens, Mycorrhiza, Fungus-insect mutualism. Parasites - Common fungal parasites of plants, humans, insects and nematodes. Saprophytes - Fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi. Agricultural significance of Fungi - Mycoparasite, mycoherbicide.

Module4 : Physiology of Fungi (2hrs)

Fungal Metabolic pathways, Secondary metabolic pathways, Mycotoxins Aflatoxins, Amatoxin, Ergot, Fusarin (general account) Antibiotics (Brief introduction only)

Practical (36 hrs)

1. Critical study of the following types by preparing suitable micropreparations; *Stemonitis, Physarum, Saprolegnia, Phytophthora, Albugo, Rhizopus, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Phyllochora, Puccinia, Termitomyces, Pleurotus, Auricularia, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Pestalotia, Parmelia,Graphis , Usnea, Cladonia.*

2. Isolation of fungi from soil and water by culture plate technique.

3. Staining and microscopicstudy of mycorrhizal colonization in root

4. Collection and identification of common field macro fungi/lichen (10 types).Submit report with photographs

References

1. C J Alexopoulos, M Blackwell, C W Mims. Introductory Mycology (IV Edn).

2. Jim Deacon (2006). Fungal Biology (IV Edn). Blackwell Publishing.

3. L N Nair (2010). Methods of microbial and plant biotechnology. New Central Book agency (P) Ltd.

4. Kanika Sharma. Manual of microbiology: Tools and techniques.

5. G C Ainsworth, K F Sparrow, A S Sussman. The fungi: An advanced treatise.

6. H C Dube (1983). An introduction to fungi. Vikas Publ. New Delhi.

7. M E Hale. The biology of lichens.

8. A Misra, P R Agarwal. Lichens.

9. M C Nair, S Balakrishnan (1986). Beneficial fungi and their utilization. Sci. publ. Jodhpur.

10. V Ahamjian, M E Hale. The Lichens.

11. R Dayal. Predaceous Fungi. Commonwealth Publishers.

12. K.S. Bilgrami and R.N. Verma. Physiology of Fungi 3rd revised edition, Scientific Publishes (India)

CROP PATHOLOGY (36 hrs)

Module 1: Introduction to crop pathology (2 hrs)

Classification of plant diseases based on; Major causal agents - biotic and abiotic, General symptoms.

Module 2: Process of infection and pathogenesis (4 hrs)

Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic. Host-parasite interaction, enzymes and toxins in pathogenesis.

Module3: Defense mechanism in plants (4 hrs)

Pre-existing structural and biochemical defense mechanisms, lack of essential nutrients. Induced structural and biochemical defense mechanisms, Inactivation of pathogen enzymes and toxins. Altered biosynthetic pathways. Phytoalexins.

Module 4: Transmission of plant disease (3 hrs)

Spread and transmission of plant diseases by wind, water, seeds and vectors.

Module 5: Plant disease management (8 hrs)

Exclusion, eradication and protection. Chemical means of disease control – common fungicides, antibiotics and nematicides. Biological means of disease control.Biotechnological approaches to disease resistance: Fungi in agricultural biotechnology, control of fungal plant pathogens by mycofungicides. Transgenic approaches to disease resistance.

Module 6: Major diseases in plants (15 hrs)

Cereals: Rice - blast disease, bacterial blight; Wheat - black stem rust disease. Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease. Fruits: Banana - bacterial leaf blight, Bunchy top; Mango - Anthracnose; Citrus - bacterial canker; Papaya – mosaic. Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease. Oil seeds: Coconut - grey leaf spot, bud rot disease. Rubber yielding: *Hevea braziliensis* - abnormal leaf fall, powdery mildew. Sugar yielding: Sugarcane - red rot; root knot nematode. Cash crops: Arecanut –Mahali disease. Beverages: Tea - blister blight; Red rust; Coffee – leaf rust.

Practical (18 hrs)

1. Identify the diseases mentioned in the syllabus with due emphasis on symptoms and causative organisms by Herbarium/ live specimen.

2. Isolation of pathogens from diseased tissues (leaf, stem, fruit and seed) by blotter / culture methods.

3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.

4. Culture media preparation and sterilization PDA/ Czapek dox's medium

References

1. K S Bilgrami, H C Dube. A text book of modern plant pathology.

2. Gareth Johnes. Plant pathology: principles and practice.

3. R S Mehrotra. Plant Pathology.

4. M N Kamat. Practical plant pathology.

5. V K Gupta, T S Paul. Fungi and Plant disease.

6. Malhotra, Aggarwal Ashok. Plant Pathology.

7. Rangaswamy, A Mahadevan. Diseases of crop plants in India.

8. B P Pandey. Plant Pathology.

9. George N Agrios (2006). Plant pathology (V Edn). Elsevier Academic Press.

BY010103: BRYOLOGY AND PTERIDOLOGY

(Theory 36 + 36 = 72 Hrs; Practical 18 + 36= 54 Hrs) Credits: 4

Module 1: Introduction (4hrs)

Diversity in forms habit and habitat. Origin and evolution of bryophytes. Trends in classification of Bryophytes: traditional and modern systems of classification (Rothmaler1951, Goffinet *et al* 2008) Contributions of Indian bryologists (Shiv Ram Kashyap, SK Pande, SC Srivastava). Fossil bryophytes.

Module 2: Ecological significance of bryophytes (3hrs)

Ecological significance of bryophytes with special reference on environmental monitoring. Water relations and regeneration techniques. Symbiotic associations of bryophytes.

Module 3: Economic importance of bryophytes (3hrs)

Economic importance of bryophytes.Cultivation and conservation of bryophytes *with* special note on *In vitro* culture techniques of bryophytes (brief description only).

Module 4: General characters and thallus organization (26 hrs)

General characters and comparative account of sporophyte, gametophyte, their interrelationships, spore dispersal mechanisms of following orders with reference to the types mentioned in the practical (development of sex organs not necessary).Hepaticopsida (Sphaerocarpales, Marchantiales, Jungermanniales and Calobryales)Anthocerotopsida (Anthocerotales).Bryopsida (Sphagnales, Polytrichales and Bryales).

Practical (18 hrs)

1. Detailed study of the structure of gametophytes and sporophytes of the following genera of Bryophytes by suitable micropreparation: *Riccia, Targionia, Cyathodium, Marchantia, Lunularia,Dumortiera, Reboulia, Pallavicinia, Porella, Anthoceros, Notothylas, Sphagnum, Pogonatum*.

2. Students are expected to submit a report of field trip to bryophytes natural habitats to familiarize with the diversity of bryophytes.

References

1. Kashyap S R (1932). *Liverworts of Western Himalayas and the Punjab plains* (Vol. I & II). Research Co. Publications.

2. Chopra R N, P K Kumar (1988). *Biology of Bryophytes.* Wiley Eastern Ltd.

3. Chopra R S, S S Kumar (1981). *Mosses of Western Himalayas and adjacent plains*. Chronica Botanica.

4. Kumar S S (1984). *An approach towards phylogenetic classification of Mosses*. Jour. Hattori Bot. Lab. Nichinan, Japan.

5. Rashid A (1981). *An Introduction to Bryophyta*. Vikas publishing house Pvt. Ltd.

6. Richardson D H S (1981). *Biology of Mosses*. Blackwell Scientific publications, Oxford.

7. Shefield W B (1983 – '84). *Introduction to Bryology* (Vol. 1, 2). Jour. Hattori Bot. Lab, Nichinan, Japan.

8. Vashishta B R, A K Sinha, A Kumar (2003). *Bryophyta*. S Chand & Co. Ltd.

9. Udak R (1976). *Bryology in India*. Chronica Botanica Co.

10. Pandey B P (1994). *Bryophyta.* S Chand and Co. Ltd.

11. Goffinet B, A J Shaw (2009). *Bryophytic Biology* (II Edn). Cambridge University Press.

12. Dyer A F, J G Duckett (Eds) (1984). *The experimental Biology of Bryophytes*. Academic Press.

13. Bonver F O (1935). *Primitive land plants*. MacMillan & Co. Ltd.

14. Campbell, Ditt (1940). *The evolution of land plants*. Stanford University Press.

15. Srivastava S N (1992). *Bryophyta*. Pradeep Publications.

PTERIDOLOGY (36hrs)

Module 1: General introduction (2 hrs)

Introduction, general characteristics and origin of Pteridophytes(Anthocerotan theory and algal origin)

Module 2: Classification and evolution of Pteridophytes (9 hrs)

Classification by Smith (1955), Zimmermann (1959) and a brief account of classification by pteridophyte phylogeny Group – PPG-2016 (up to order).Evolution: Telome theory, Stelar evolution in pteridophytes.Heterospory and seed habit in pteridophytes.

Module3: Structure of the plant body (20 hrs)

Distribution, habitat, morphology,anatomy of sporophytic and gametophytic generation and reproduction of the following classeswith reference to the genera mentioned (development of sex organs is not necessary).

Division: Psilophyta.
Class-Psilophytopsida,
Order – Psilophytales-Rhynia
Class-Psilotopsida,
Order – Psilotales-Psilotum

Division: Lycophyta.
Class- Eligulopsida,
Order lycopodials-Lycopodium
Class- Ligulopsida
Order-Selaginellales-Selaginella
Order – Isoetales-Isoetes,
Order – Pleuromeiales-Pleuromeia
Order – Lepidodendrales-Lepidodendron, Lepidocarpon and Stigmaria
Division: Sphenophyta (Calamophyta)
Class- Sphenophyllopsida.
Order – Sphenophyllales-Sphenophyllum
Class-Calamopsida,
Order – Equisetales-Equisetum.
Division:Filicophyta.
Class- Eusporangiopsida
Order –Ophioglossales-Ophioglossum
Order – Marattiales-Angiopteris
Class- Protoleptosporangiopsida
Order – Osmundales-Osmunda
Class- Leptosporangiopsida
Order – Filicales-Pteris, Adiantum, Gleichenia and Lygodium
Order– Marsileales-Marsilea
Order – Salviniales-Salvinia and Azolla.
Class- Primopteropsida
Order – Cladoxylales-Cladoxylon
Order –Coenopteridiales

Module 4: Developmental studies in Pteridophytes (3 hrs)

Development of sporangium, mechanism of spore dispersal. Apogamy and apospory in pteridophytes.

.

Module 5: Ecological and economic importance (2 hrs)

Ecological significances: Diversity of macro and micro habitats of Pteridophytes in the major ecosystems. Ecological roles by pteridophytes: stabilization of disturbed habitats, prevention of soil and nutrient leaching, micro-habitats for seed/spore germination. Economic importance of pteridophytes: General- as garden plants, as food/food supplements, as medicine, as other useful items. Pollution control phyto- remediation by ferns. Biofertilizer- *Azolla-Anabaena*- model.

Practical (36 hrs)

1. Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera:

Lycopodium, Isoetes, Selaginella, Equisetum, Psilotum, Angiopteris, Ophioglossum, Osmunda, Marsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia (Dicranopteris), Pteris and *Adiantum.*

2. Study of fossil pteridophytes with the help of specimens and permanent slides.
3. Field trips to familiarize with the diversity of pteridophytes in natural habitats and submit a report.

References

1. Agashe S N (1995). Palaeobotany. Oxford and IBH publishing House.
2. Arnold C R (1977). Introduction to Palaeobotany. McGraw Hill Book Com.
3. Chandra S, Srivastava M (Eds) (2003). Pteridology in the New Millennium. Khuwar Acad. Publishers.
4. Beddome C R H (1970). Ferns of southern India. Today & Tommorrows Publ.
5. Dyer A F (1979). The experimental biology of ferns. Academic Press.
6. Gifford E M, A S Foster (1989). Morphology and evolution of Vascular plants (III Edn). W H Freeman & Co.
7. Khullar S P (2000). An illustrated fern flora of West Himalayas (Vol I, II). International Book Distributers.
8. Kubitzki K (1976). The families and Genera of Vascular plants: Vol. I Pteridophytes. Vikas publishing house.
9. Rashid A (1976). An introduction to Pteridophytes. Vikas Publishing House.
10. Sporne K R (1982). Morphology of Pteridophytes. Hutchinson University Press.
11. Surange K R (1964). Indian Fossil Pteridophytes. CSIR.
12. Louis J D (1977). Evolutionary patterns and processes in ferns: Advances in Botanical Research.
13. Scott. Studies in Fossil Botany. Haffner publications.
14. Smith, Gilbert (1972). Cryptogamic Botany (Vol. II). Tata McGraw Hill publications.
15. Nayar B K, S Kaur (1971). Gametophytes of homosporous ferns. Bot. Rev.
16. Bomfleur, B., McLoughlin, S. and Vajda, V., 2014. Fossilized nuclei and chromosomes reveal 180 million years of genomic stasis in royal ferns. Science, 343(6177), pp.1376-1377.
17. Christenhusz, M.J. and Chase, M.W., 2014. Trends and concepts in fern classification. Annals of Botany, 113(4), pp.571-594.
18. Eriksson, T., 2004. Evolutionary biology: Ferns reawakened. Nature, 428(6982), p.480.
Lehtonen, S., Silvestro, D., Karger, D.N., Scotese, C., Tuomisto, H., Kessler, M., Peña, C., Wahlberg, N. and Antonelli, A., 2017. Environmentally driven extinction and opportunistic origination explain fern diversification patterns. Scientific Reports, 7(1), p.4831.
19. Li, F.W., Melkonian, M., Rothfels, C.J., Villarreal, J.C., Stevenson, D.W., Graham, S.W., Wong, G.K.S., Pryer, K.M. and Mathews, S., 2015. Phytochrome diversity in green plants and the origin of canonical plant phytochromes. Nature communications, 6, p.7852.
20. Li, F.W., Villarreal, J.C., Kelly, S., Rothfels, C.J., Melkonian, M., Frangedakis, E., Ruhsam, M., Sigel, E.M., Der, J.P., Pittermann, J. and Burge, D.O., 2014. Horizontal transfer of an adaptive chimeric photoreceptor from bryophytes to ferns. Proceedings of the National Academy of Sciences, 111(18), pp.6672-6677.
21. Mehltreter, K., Walker, L.R. and Sharpe, J.M. eds., 2010. Fern ecology. Cambridge University Press.

22. Pryer, K.M., Schneider, H., Smith, A.R., Cranfill, R., Wolf, P.G., Hunt, J.S. and Sipes, S.D., 2001. Horsetails and ferns are a monophyletic group and the closest living relatives to seed plants. Nature, 409(6820), p.618.
23. Ranker, T.A. and Haufler, C.H. eds., 2008. Biology and evolution of ferns and lycophytes. Cambridge: Cambridge University Press.
24. Ranker, T.A. and Sundue, M.A., 2015. Why are there so few species of Ferns. Trends in plant science, 20(7), pp.402-403.
25. Rothfels, C.J., Johnson, A.K., Hovenkamp, P.H., Swofford, D.L., Roskam, H.C., Fraser-Jenkins, C.R., Windham, M.D. and Pryer, K.M., 2015. Natural hybridization between genera that diverged from each other approximately 60 million years ago. The American Naturalist, 185(3), pp.433-442.
26. Rothfels, C.J., Li, F.W., Sigel, E.M., Huiet, L., Larsson, A., Burge, D.O., Ruhsam, M., Deyholos, M., Soltis, D.E., Stewart, C.N. and Shaw, S.W., 2015. The evolutionary history of ferns inferred from 25 low-copy nuclear genes. American Journal of Botany, 102(7), pp.1089-1107.
27. Schneider, H., Schuettpelz, E., Pryer, K.M., Cranfill, R., Magallón, S. and Lupia, R., 2004. Ferns diversified in the shadow of angiosperms. Nature, 428(6982), p.553.
28. PPG 1. 2016. A community-derived classification for extant lycophytes and ferns. Journal of Systematics and Evolutiona 54 (6), pp. 563–603

BY010104: GYMNOSPERMS, PALAEOBOTANY AND EVOLUTION

(Theory: 27 + 09 + 18= 54 hrs; Practical: 27 hrs) Credits: 4

GYMNOSPERMS (27 hrs)

Module 1: Introduction (3 hrs)

General characteristics, distribution and classification of gymnosperms (K R Sporne). Brief account of classification by Christenhusz*et al.*, (2011). Distribution of living gymnosperms in India.

Module 2: Vegetative and reproductive structures of Gymnosperms (20 hrs)

Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned).

Class Cycadopsida: *Lyginopteris, Lagenostoma, Glossopteris, Medullosa, Caytonia. Bennettites, Williamsonia, Pentoxylon,Cycas, Zamia.* Class Coniferopsida: General account of families under Coniferales, range of form and structure of stem, leaves. Range of form and structure of female cones in Coniferales -*Pinus, Cupressus, Podocarpus, Agathis, Araucaria, Taxus and Ginkgo*.Class Gnetopsida: *Gnetum*. General account of Ephedraceae and Welwitschiaceae

Module 3: Gametophyte development of Gymnosperms (2 hrs)

General account on the male and female gametophyte development in Cycas. Comparative study of male gametophytes of living Coniferales

Module4: Economic importance of Gymnosperms (2 hrs)

Economic importance of gymnosperms; pharmacological importance of *Ginkgo*

Practical (27 hrs)

1. Study the morphology and anatomy of vegetative and reproductive parts of *Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria, Podocarpus* and *Gnetum.*
2. Study of fossil gymnosperms through specimens and permanent slides.
3. Conduct field trips to familiarize various gymnosperms in nature and field, identification of Indian gymnosperms and submit a report.

References

1. Andrews H N Jr (1961). *Studies in Palaeobotany*. John Wiley and sons.
2. Arnold C A (1947). *An introduction to Palaeobotany*. John Wiley and sons.
3. Beck C E (1995). *Gymnosperm Phylogeny*. Bot. Rev. 51-176.
4. Bhatnagar S P, Moitra A (2000). *Gymnosperms*. New Age International Ltd.
5. Biswas C. *The Gymnosperms*. Today and Tomorrows print.
6. Chamberlain C J (1935). *Gymnosperms: Structure and Evolution*. University of Chicago Press.
7. Christenhusz M J M, Reveal J C, Farjon A, Gardner M F, Mill R R, Chase MW (2011). *A new classification and linear sequence of extant gymnosperm*. Phytotoaxa, 19:55-70.

8. Coulter J M, Chamberlain C J (1977). *Morphology of Gymnosperms*. University of Chicago Press.
9. Dallimore W, A B Jackson (1964). *A Handbook of Coniferae and Ginkgoaceae* (IV Edn). Edward Arnold & Co.
10. Delevoryas T (1962). *Morphology and evolution of Fossil Plants*. Holt, Rinehart and Winston.
11. Dettmann M E, Clifford H T (2005). Biogeography of Araucariaceae. In Dargavel (ed) Australia and New Zealand forest histories: auraucarian forests. Australian Forest History Society Inc. Occasional Publication 2: 1-9.
12. Hori T, Ridge R W, Tulecke W, Del P T, Tremouillaux-Guiller J, Tobe H (Eds.) (1997). *Ginkgo Biloba A Global Treasure.* From Biology to Medicine. Springer.
13. Khuraijam J S, Singh R (2015). *Gymnosperms of Northeast India: distribution and conservation status.* Pleione (East Himalayan Society for Spermatophyte Taxonomy)9: 283 – 288.
14. Pant D D (2002). An introduction to Gymnosperms, Cycas and Cycadales. Birbal Sahni Institute of Palaeobotany, Monograph no. 4.
15. Sahni, K. C. 1990 Gymnosperms of India and adjacent countries. Bishen Singh Mahendra Pal Singh, Dehradun.
16. Sharma O P, S Dixit (2002). *Gymnosperms*. Pragati Prakashan.
17. Singh B, Kaur P, Gopichand, R D, Singh P S Ahuja (2008). *Biology and chemistry of Ginkgo biloba.* Fitoterapia 79:401–418.
18. Sporne K R (1974). *The morphology of gymnosperms*. Hutchinson Univ. Library.
19. Srivastava R C (2006). *Diversity, distribution and economic importance of living gymnosperms of India*. Punjab University Research Journal, 56:45-87.

PALEOBOTANY (Theory: 9 hrs; Practical: 9 hrs)

Module 1: Introduction (1 hr)

Evolutionary Time scale: Eras, Periods and Epochs (Including: Meghalayan, Northgrippian and Greenlandian ages).

Module2: Fossils (3 hrs)

Fossils-Definition, types.Fossilization: mode of preservation and their importance. Stages in primate evolution-including *Homo*.

Module 3: Techniques and Preservation (3 hrs)

Techniques in Palaeontology: Mega and Micro-fossils, Nanofossils, Ichnofossils- collection. Reformation and illustration- Binomial Nomenclature. Methods of Plant-fossil studies: Preservation and preparation, age determination: Carbon dating.

Module4: Nomenclature and applied aspects (2 hrs)

Fossil record: Systematic, reconstruction and nomenclature. Fossil records from India. Applied aspects of Paleobotany.

References

1. Agashe S. N. (1995). *Palaeobotany*. Oxford & IBH, New Delhi.
2. Ruap D. M. and Stanley S.M (1999). *Principles of Palaeontology*. W.H. Freeman and Co. Toppan Co. Ltd.
3. Siddiqui, K.A. (2002). *Elements of Palaeobotany*. Kitab Mahal. Allahabad.
4. Stewart, W.N. and Rothwell G.W. (1993). *Palaeobotany and the Evolution of Plants*. Cambridge University Press.
5. Thomas, B.A. & Spicer R.A. (1987). *The Evolution and Palaeobiology of land plants*. Discordies Press, Fortland, USA.

EVOLUTION: (Theory: 18 hrs)

Module 1: Introduction (3 hrs)

Evolution of biomes. Mixing process, intercontinental connections. Climatic zonations, dispersal opportunities, dispersal availability, sub-climax and climax dispersal. Phylogeny and age of biomes: Interwoven biome phylogeny and biome extension and resurrection.

Module 2: Evidences for evolution (2 hrs)

Morphology, comparative anatomy, embryology, physiology,biochemistry, paleontology and biogeography. Micro and macro-evolution and punctuated equilibrium.

Module3: Natural Selection (3 hrs)

Natural selection and adaptation. Nature of natural selection, limiting factors, origin of races and species, Kins Selectionand Hamilton's Rule. Rate of evolutionary change: Internal and external-factors. Significance of genetic drift in natural selection.

Module 4: Mutation as an Evolutionary Force (3 hrs)

Mutation and genetic divergence. Evolutionary significance of mutations. Genetic assimilations (Baldwin effect). Genetic homoeostasis. Mutation for natural selection. Eugenics and euthenics.

Module 5: Speciation (3 hrs)

Species concept; morphological species, biological species and evolutionary species. Mode of speciation – allopatric, sympatric and parapatric. Types of Speciation-Phyletic and true-speciation. Hybridization (Double cross hybrid of field Corn); Rate of hybridization and introgression in evolution of species. Reproductive isolation: Pre-zygotic and post-zygotic isolation.

Module6: Co-evolution (2 hrs)

Symbiosis. Plant-animal Co-evolution; mutualism, commensalism.Protective -colouration and shape. Mimicry: Batesian and Mullerian mimicry.Molecular tools in phylogeny.

References

1. Allan C. Hutchinson (2005). *Evolution and the Common Law*. Cambridge University Press.
2. Douglas J. Futuyma (2009). *Evolution*. Sinauer Associates. INC-Publishers. USA.
3. George Ledyard Stebbins (1971). *Process of Organic evolution*.
4. Gurbachan S. Miglani (2002). *Modern Synthetic theory of evolution*.

5. Hancock J. F (2003). *Plant Evolution and the Origin of Crop Species*. CABI.
6. Herbert H. Ross (1962). *A Synthesis of Evolutionary Theory*. Prentice Hall Of India.
7. Horatio Hacketrt Newmann (1932). *Evolution, Genetics and Eugenics*. University of Chicago press.
8. Katy Human (2006). *Biological evolution: An anthology of current thought.* The Rosen publishing group, Inc.
9. Kenneth V. Kardong (2005). *An introduction to Biological Evolution*. McGraw-Hill publications. New York.
10. Martin Ingrouille and Bill Eddie (2006). *Plants Diversity and Evolution*. Cambridge University Press.
11. Maxtoshi Nei and Sudhir Kumar (2000). *Molecular Evolution and phylogenetics*. Oxford University Press.
12. Monroe W. Strickberger (1990). *Evolution*. Jones and Bartlett publishers.
13. Paul Amos Moody (1970). *Introduction to Evolution*. Harper and Row publishers, Newyork.
14. Roderic D. M. Page and Edward C. Holmes (1998). *Molecular Evolution: A Phylogenetic approach*. Blackwell Science Ltd.
15. Shukla R. S. and P. S.Chandel (1974). *Cytogenetics, Evolution, Biostatistics and Plant Breeding*. S.Chand and Company Ltd. New Delhi.
16. Victor Rico-Gray, Paulo S. Oliveira (2007). *The Ecology and Evolution of Ant-Plant Interactions*. University of Chicago Press.
17. Volpe E. Peter (1993). *Understanding Evolution*. Universal Book Stall, New Delhi.
18. Willis K. J. and J. C. Mc Elwain (2002). *The Evolution of Plants*. Oxford University Press.

MODEL QUESTION PAPERS - THEORY

M. Sc. Botany Degree (C.S.S) Examination

I Semester

Faculty of Science

BY010101: Microbiology and Phycology
(2019 admissions onwards)

Time: Three hours **Max. Weight: 30**

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is metagenomics?
2. Name two parasitic algae
3. Distinguish between valve and girdle of diatoms
4. Comment on nanobes
5. Define Palmelloid stage, cite an example
6. Mention the toxin and causative organism of Amnesic shell fish poisoning
7. Mention major groups and divisions of classification by Lee
8. How will you sterilize bacterial culture medium?
9. Define SCP with suitable examples
10. Distinguish between virions and viriodes

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Describe the thallus structure of Phaeophyceae
12. Describe the ultrastructure of bacterial flagella
13. Comment on algal symbiosis
14. Describe algal cell components
15. Give an account on various sterilization techniques in microbiology
16. Describe major life cycle patterns in Chlorophyceae
17. Explain allelopathy and microalgae
18. What are endophytes? Explain their role in plant growth promotion

(**6 x 2 = 12**)

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Give a detailed account on isolation, maintenance and preservation of pure cultures of bacteria
20. Illustrate triphasic life cycle in algae with suitable examples
21. What are algal blooms? describe causative organisms, symptoms and toxins of major toxic algal blooms
22. Explain the life cycle of viruses

(2 x 5 = 10)

M. Sc. Botany Degree (C.S.S.) Examination

I Semester

Faculty of Science

BY010102: Mycology and Crop Pathology
(2019 admissions onwards)

Time: Three hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is sclerotium?
2. What is crozier formation? Give example.
3. Describe the structure of basidium.
4. Distinguish between sporangium and conidium
5. What is meant by coprophilous fungi? Give any two examples
6. Deuteromycetes are also known as fungi imperfecti. Why?
7. What is puckering?
8. What is meant by horizontal resistance?
9. What are the disseminating methods of Bacterial Canker in Citrus Spp.?
10. What are the symptoms of Bunchy top Banana?

(8 x 1 = 8)

SectionB

(Answer any **six** questions. Each question carries a weight of 2)

11. Describe the structure of dolipore septa
12. Write short note on different type of fruiting bodies found in ascomycetes
13. Explain different type of conidial development in Duteromycetes
14. Describe the structure of spermagonium in *Puccinia graminis*
15. Illustrate the life cycle of *Physarum polycephalum*
16. Write short note on the Uredospore survival of *Puccina graminis tritici* in India
17. Writeshort note on the symptoms, causativeorganismand control measures of Mahali disease of Arecanut.
18. What are the resistant verities of paddy against Bacterial blight?

(**6 x 2 = 12**)

SectionC

(Answer any **two** questions. Each question carries a weight of 5)

19. Describe the life cycle of *Puccinia graminis tritici*. with illustrations
20. Explain the classification of Fungi by C. J. Alexopoulos and Mims
21. What are the principles of plant disease control? Explain
22. Describe the symptoms, causative organism and control of Mosaic diseases

(**2 x 5 = 10)**

M Sc Degree (C.S.S) Examination

First semester

Faculty of science

BY010103:Bryology and Pteridology

(2019 Admission onwards)

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What are endohydric bryophytes?
2. Explain the term synangium.

3. Define apospory.
4. Name two aquatic ferns.
5. What are gemma cups?
6. Write the ecological significance of bryophytes.
7. What are elaters?
8. Write the significance of heterospory.
9. Explain the term protocorm.
10. Why *Azolla* is considered as a biofertilizer?

(8 x 1 = 8)

Section B

(Answer any six questions, each question carries a weight of 2).

11. Describe *Lepidodendron.*
12. Explain the morphological characteristics of *Psilotum.*
13. Describe vegetative reproduction in bryophytes.
14. Explain the morphology of *Ophioglossum.*
15. Write notes on heterospory and seed habit.
16. Describe the reproductive structure in *Osmunda.*
17. Write notes on conservation and cultivation of bryophytes
18. Write an account of the sporophyte of *Sphagnum*.

(2x6= 12)

Section C

(Answer any two questions, each question carries a weight of 5)

19. Describe the origin and habitat diversity of bryophytes.
20. Describe origin, organization and evolution of stele in pteridophytes.
21. Compare the gametophyte and sporophyte of hepaticopsida and bryopsida.
22. Compare the features of Psilophytales and Psilotales and write notes on the evolutionary significance of these groups.

(2x5=10)

M. Sc. Botany Degree (C.S.S) Examination

I Semester

Faculty of Science

BY01014: Gymnosperms, Palaeobotany and Evolution
(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Mention the orders in class Cycadospsida by Sporne
2. Describe Baldwin effect
3. Name two stem genera of fossil gymnosperms
4. Define mimicry
5. What is yew wood
6. Define copal
7. Write brief note on fossil records from India
8. Define carbon dating
9. Comment on modern coniferales
10. Define cupule

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Mention the similarities and differences of gymnosperms with pteridophytes and angiosperms
12. Distinguish between mutualism and commensalism
13. Comment on the distribution of living gymnosperms in India
14. Describe Kins Selectionand Hamilton's Rule
15. Describe the economic importance of gymnosperms
16. Mention the evolutionary time scale with eras and periods
17. Describe pharmacological importance of *Ginkgo*
18. Significance of genetic drift in natural selection

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. With suitable diagrams, describe the stelar anatomy of Medullosaceae and Pentoxylaceae
20. Describe the evidences of evolution
21. Describe the salient features of Podocarpaceae and Araucariaceae
22. Write an essay on speciation

(2 x 5 = 10)

MODEL QUESTION PAPERS – PRACTICAL

SEMESTER I - PRACTICAL COURSE I
BY010105: MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND CROP PATHOLOGY

Time: 4 hours **Weightage:30**

1. Make suitable micropreparations of A, B and C. Draw labeled diagrams and identify giving reasons.
(Total weight 2.5 = Preparation – 1, Diagram – 0.5, Identification with reasons – 1; 2.5 x 3 = 7.5)
2. Write critical notes on D and E.
(Total weight 1 = Identification – 0.5, Critical note – 1; 1.5 x 2 = 3)
3. Sort out any fouralgae from the algal mixture F and make separate clear mounts. Identify and draw labeled diagrams.
(Total weight 1.5 = Preparation – 0.5, Identification = 0.5, Diagram – 0.5; 1.5 x 4 = 6)
4. Spot at sight G, H and I.
(Total weight 1 = Identification 0.5, Part displayed = 0.5; 1 x 3 = 3)
5. Identify the disease in J, K and L and write the causative organism.
(Total weight 1 = Identification – 0.5, Causative organism – 0.5; 1 x 3 =3)
6. (a) Isolate Bacteria from the soil sample M by serial dilution and streak out by quadrate method.
(Total weight 2 = Working – 1, Procedure – 1)
7. Submit three specimens of plants showing typical disease symptoms
(Total weight 1.5 = 0.5 x 3 = 1.5)
8. Practical record
(Weight = 4)

Key to the questions:
1. A, B, C: Alga, Fungi/Lichen.
2. D, E - Fungi.
3. F – Algal mixture containing five filamentous types.
4. G, H, I – macroscopic or microscopic specimens from algae, fungi/lichen with clear and distinguishable identifying characters.
5. J, K, L – Herbarium or live/dry specimen showing the symptoms of any disease specified in the syllabus
6. M - Supply necessary soil sample.
7. Credit for specimens showing typical symptoms – include a short report on the disease.
8. Awarding 'A grade' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly. This also includes field study report(s)/Lab visit report(s), if any.

SEMESTER I - PRACTICAL COURSE II
BY010106: BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, AND PALEOBOTANY
Model question paper

Time: 4 hours **Weightage: 30**

1. Make stained micropreparations of specimens A, B, C and D. Drawlabeled diagrams for each and identify giving reasons.
(Total weight 2.5 = Preparation - 1, Diagram – 0.5, Identification with reasons – 1; 2.5 x 4 = 10)
2. Make stained micropreparations (TS, TLS and RLS) of E. Draw labeled diagram and identify giving reasons.
(Total weight 5.5 = Preparations – 1 each, Identification with reasons - 1, Diagrams - 0.5 each)
3. Identify at sight F, G, H, I and J.
(Total weight 1 = Genus identification - 0.5, Part displayed - 0.5; 1 x 5 = 5)
4. Write critical notes on the reproductive structures K and L.
(Total weight 3 = Identification – 0.5, Critical note – 1; 2 x 1.5 = 3)
5. Identify and write a critical note on M
(Total weight 1.5 = Identification – 0.5, Critical note - 1)
6. Practical record
(Weight = 5)

Key to the questions:
1. A, B, C, D - Two suitable specimens from Pteridophytes, one from Bryophytes and a Gymnosperm leaf.
2. E–Suitable specimen from Gymnosperms.
3. F, G, H, I, J – Suitable specimens from Bryophytes, Pteridophytes and Gymnosperms; both reproductive and/or vegetative structures; should not exceed two specimens from one group.
4. K, L – Specimens from Bryophytes, Pteridophytes and Gymnosperms.
5. M - Fossil slides/specimens/photographs of types specified in the syllabus; both vegetative and reproductive structures included.
6.Awarding 'A grade' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly.This also includes field study report(s)/Lab visit report(s), if any.

SEMESTER II

SECOND SEMESTER COURSES

BY010201	PLANT ANATOMY, DEVELOPMENTAL BIOLOGYAND HORTICULTURE
BY010202	CELL BIOLOGY, GENETICS AND PLANT BREEDING
BY010203	PLANT PHYSIOLOGY AND BIOCHEMISTRY
BY010204	MOLECULAR BIOLOGY
BY010205	PLANT ANATOMY, DEVLOPMENTAL BIOLOGY, HORTICULTURE, CELL BIOLOGY, GENETICS AND PLANT BREEDING - PRACTICAL
BY010206	PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY - PRACTICAL

Total Credits: 19
Total Hours: 450

BY010201: PLANT ANATOMY, DEVELOPMENTAL BIOLOGY AND HORTICULTURE

(Theory: 36 + 18+ 18= 72 Hrs; Practical:27 + 09 + 09= 45 Hrs) Credits: 4

PLANT ANATOMY (Theory: 36 Hrs; Practical: 27 Hrs)

Module 1: Introduction (1 hr)
Scope and significance of plant anatomy. Role of anatomy in phylogeny.

Module 2: Meristem (4 hrs)
Apical organization: Stages of development of primary meristem and theories of apicalorganization (shoot and root). Origin of branches. Primary Thickening Meristem (PTM) in Monocots. Secretory tissues in plants. Structure and distribution of secretory trichomes (e.g. *Drocera,Nepenthes*), Salt glands, collectors, nectaries, resin ducts and laticifers.

Module 3: Secondary Structure (16 hrs)
Mechanical tissues in plants.Structure and functions. Vascular cambium and cork cambium: Structure and functions.Factors affecting cambial activity. Secondary xylem: ontogeny, structure, components and functions.Origin of vessel in angiosperms and dilation of rays. Axial parenchyma distribution in wood.Secondary phloem: Ontogeny, structure, components and functions. Stelar and extra stelar thickening in angiosperms. Reaction wood, compression wood and tension wood.Factors affecting reaction wood formation. Dendrochronology: Growth rings and their functions.Summer and Spring-wood.Anomalous secondary growth in dicots and monocots. Tyloses: Structure and function. Plant fibers: distribution, structure and commercial importance of coir, jute, and cotton. Root-stem transition in angiosperms.

Module 4: Leaf and Node (4 hrs)
Leaf: ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Leaf abscission. Nodal anatomy: unilacunar, trilacunar and multilacunarnodes, nodal evolution; role of nodal anatomy in taxonomy.

Module 5: Reproductive Anatomy (8 hrs)
Floral anatomy: Anatomy of floral parts - sepal, petal, stamen and carpel, vascular anatomy of flower and modifications. Development of epigynous ovary-appendicular and receptacular theory, role of floral anatomy in taxonomy. Fruit and seedanatomy - anatomy of fleshy and dryfruits - follicle, legume and berry. Dehiscence of fruits. Anatomy of seeds.

Module 6: Applied Anatomy (3 hrs)

Research prospects in anatomy. Applications of Anatomy in Systematics (Histotaxonomy) and Pharmacognosy.

Practical(27 Hrs)

1. Study the Anomalous- Primary and Secondary features in:

Bignonia, Amaranthus, Nyctanthes, *Piper, Bougainvillea* and *Strychnos*.

2. Study of stomatal types (Anomocytic, anisocytic, paracytic and piacytic) and determination of stomatal index.

3. Study of nodal patterns (Unilacunar. Trilacunar and Multilacunar).

References

1. Charles B. Beck (2010). *An Introduction to Plant Structure and Development_ Plant Anatomy for the Twenty-First Century*. Cambridge University Press.
2. David F. Cutler, Ted Botha, Dennis W. M. and Stevenson (2008). *Plant Anatomy: An Applied Approach*.Wiley-Blackwell.
3. Eames A. J, Mc Daniel (1976). *An introduction to plant Anatomy*.
4. Edred John Henry Corner (1976). *The seeds of dicotyledons* (Vol. I & II). Cambridge University Press.
5. Elizabeth G. Cutter (1978). *Applied Plant Anatomy*. Clive and Arnald Ltd.
6. Elizabeth G. Cutter (1978). *Plant anatomy part I & II*. Clive and Arnald Ltd.
7. Ella Werker (1997). *Seed Anatomy*. Borntreager.
8. Esau K. (1965). *Vascular differentiation in plants*. Rirehant and Winston, Inc.
9. Esau K. (1977). *Anatomy of seed plants*. Wiley and sons.
10. Fahn A. (1997). *Plant anatomy*. Aditya Publishers.
11. Foster A. S. *Practical plant Anatomy*.
12. Fritz Hans Schweingruber, Annett Borner and Ernst-Detlef Schulze (2008). *Atlas of Woody Plant Stems. Evolution, Structure, and Environmental Modifications*. Springer.
13. Ingrid Roth (1977). *Fruits of Angiosperm*. Gebruder Borntreager.
14. John A. Romberger, Zygmunt Hejnowicz and Jane F. Hill (2005). *Plant Structure Function and Development. A Treatise on Anatomy and Vegetative Development, with Special Reference to Woody Plants*. Springer-Verlag.
15. Metcalf C. R. and Chalk L. (1950). *Anatomy of Dicotyledons and Monocotyledons*.
16. Metcalf C. R. and Chalk L. (1983). *Anatomy of the dicotyledons: Wood structure and conclusion of the general introduction*. Oxford University press.
17. Pandey B. P. *Plant Anatomy*. S Chand and Co. New Delhi.
18. Paula J. Rudall (2007). *Anatomy of Flowering Plants. An Introduction to Structure and Development*. Cambridge University Press.
19. Ray F. Evert, Susan E. and Eichhorn (2007). *Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body, Their Structure, Function, and Development*.Wiley-Liss.
20. Sherwin John Carlquist (2001). *Comparative wood anatomy: Systematic, ecological, and evolutionary aspects of dicotyledon wood*.
21. Taylor A. Steeves, Vipen K. Sawhney (2017). *Essentials of developmental plant anatomy*.Oxford University Press.
22. Vasishta P. C. (1994). *Plant anatomy*. Pradeep publications.
23. William C. Dickison (2000). *Integrative plant anatomy*. Academic Press.

DEVELOPMENTAL BIOLOGY (Theory: 18 Hrs+ Practical: 9 Hrs)

Module 1: History and Basic Concepts of Development (5hrs)

Overview on the modern era of developmental biology emerged through multidisciplinaryapproaches. Stages of development- zygote, blastula, gastrula, neurula. Cell fate and commitment, potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map. Mechanisms of differentiation-cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development. Pattern formation-axis specification, positional identification (regional specification). Morphogenetic movements. Model organism in developmental biology (Arabidopsis-brief account only)

Module 2: Overview of Plant Development (9 hrs)

Angiosperm life cycle. Anther: microsporogenesis and microgametogenesis. Viability of pollen grains. Pollination, pollen germination, growth and nutrition of pollen tube, pollen morphology, exine sculpturing, pollenkitt NPC formula.Ovule: megasporogenesis and mega gametogenesis. Types of embryosac and development. Fertilization: Double fertilization; embryo development - different types. Endospermdevelopment, types of endosperm, haustorial behavior of endosperm. Xenia and metaxenia. Polyembryony – types and causes. Seed formation, dormancy and germination. Apomixis, parthenogenesis

Module 3: Morphogenesis and Organogenesis in Plants: (4 hrs)

Organogenesis in plants, transition to flowering, floral meristems and floral development. Homeoticgenes in plants.

Practical (9hrs)

1. Embryo excision from young seeds.

2. Identification of different types of ovules, embryos, polyembryony, endosperm, pollen grains, anther growth stages.

References

1. Scott F Gilbert (2000). Developmental Bilogy (IX Edn). Sinauer Associates.

2. R M Twyman (2001). Instant notes in Developmental Biology. Viva Books Private Limited.

3. Lincoln Taiz, Eduardo Zeiger (2002). Plant physiology (II Edn). Sinaeur Associates, Inc. Publishers.

4. Robert J Brooker (2009). Genetics: analysis & principles (III Edn.). McGraw Hill

5. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). Biochemistry and Molecular biology of Plants. L K International Pvt. Ltd.

6. Scott F Gilbert (2000). Developmental Bilogy (VIII Edn). Sinauer Associates.

7. S S Bhojwani, S P Bhatnagar (1999). The Embryology of Angiosperms (IV Edn). Vikas Publishing House Pvt Ltd.

8. Maheswari P (1950). An introduction to the embryology of Angiosperms. McGraw Hill.

HORTICULTURE **(Theory: 18 Hrs Practical: 9 Hrs)**

Module 1: Introduction (2 hrs)

Introduction to Horticulture; nature and scope. Objectives of horticulture.

Module 2: Principles of Horticulture (4 hrs)

Principles of landscape gardening. Gardening: ornamental and indoor gardens, kids gardens, vertical and roof top gardens. Garden adornments. Propagation methods-layering, budding, grafting, and micropropagation-merits and demerits.

Module 3: Horticulture Applications (6 hrs)

Composting: aerobic, anaerobic and vermicomposting; mist chamber, green house and glass house. Effect of pollution on indoor plants. Commercial products of horticulture. Olericulture: home and market - gardening and truck farming. Seed production.

Module 4: Floriculture (3 hrs)

Introduction, nature and scope. Fresh and dry flower arrangements. Production of Cut flowers, cultivation of orchids, foliage potted plants and bedding plants. Future prospects of floriculture.

Module 5: Modern trends in horticulture (3 hrs)

Bonsai: Selection of plants and making of bonsai. Physical control of plant growth in Bonsai preparation. Preparation of terrarium, aquaponics and arbori culture. Components of high-tech farming.

Practical: (9 Hrs)

1. List out the Garden components in the Photograph.
2. Demonstration of Preparation of a Terrarium.
3. Propagation methods-layering and grafting.

References

1. Adam C.R. (2004). Principles of Horticulture. Elsevier Butterworth-Heinemann.
2. Peter K. V. (2015). *Basics of Horticulture*. New India Publishing Agency, New Delhi.
3. Gupta S.N. (2016). *Instant Horticulture*. Jain Brothers, New Delhi.
4. Tiwari A.K. and R. Kumar (2012). *Fundamentals of Ornamentals, Horticulture and Landscape Gardening*. New India Publishing Agency, New Delhi.

BY010202: CELL BIOLOGY, GENETICS AND PLANT BREEDING
(Theory: 27+27+18=72Hrs; Practical: 18+18+9=45 Hrs; Credits: 4)

CELL BIOLOGY (Theory: 27 Hrs; Practical: 18 Hrs)

Module 1: Introduction to plant cells (7 hrs)

Structural organization of plant cell. Plasma membrane – chemical composition, organization, membrane fluidity, dynamic nature.Ultrastructure and functions of mitochondria, peroxisomes, glyoxysomes and chloroplast. Endomembrane system – structure and functions of endoplasmic reticulum, Golgi complex, lysosomes and vacuoles. Transport of materials – biosynthetic (secretory) and endocytic pathway. Chromosomes – organization of chromatin and chromosomes - histones and nonhistone proteins, nucleosomal organization of chromatin, higher levels of chromatin organization in chromosomes. Heterochromatin and Euchromatin, formation of heterochromatin. Molecular structure of the Centromere and Telomere.

Module 2: Cell signaling (6 hrs)

Cell communication - general principles. Signaling molecules and their receptors; external and internal signals that modify metabolism, growth, and development of plants.Receptors: cell surface receptors - ion-channel linked receptors (Voltage-gated ion channels and Ligand-gated ion channels in neurons), G-protein coupled receptors (β-adrenergic receptor), Tyrosine-kinase linked receptors (Insulin receptor), and Steroid hormone receptors (Estrogen receptor). Signal transduction pathways, second messengers, regulation of signaling pathways. Bacterial and plant two-component signaling systems (Brief study).

Module 3: Cell interaction (4 hrs)

Extra cellular matrix, Cell adhesion molecules - cadherins, integrins, selectins, fibronectins, laminin and Immunoglobin superfamily. Cell-cell adhesions (Junctional and non-junctional adhesive mechanisms; occluding junctions, anchoring junctions, communicating junctions (Connexons and plasmodesmata).

Module 4: Cytoskeleton (3 hrs)

Functions of cytoskeleton; Structure, assembly, disassembly and regulation of filaments involved – actin filaments (microfilaments), microtubules, and intermediate filaments. Molecular motors – kinesins, dyneins, and myosins.

Module 5: Cell cycle and its regulation (7 Hrs)

Phases of cell cycle, mitosis and meiosis (Brief study), Spindle formation and its disintegration, Mechanisms of chromosome movement and separation during anaphase, Role of cohesins and condensins. Role of motor proteins. Cell cycle control mechanisms - extracellular an intracellular signals. Cell cycle checkpoints – DNA damage checkpoint, centrosome duplication checkpoint, spindle assembly checkpoint - role of cyclins and cyclin dependent kinases. Apoptosis – process of programmed cell death, extrinsic and intrinsic pathways of apoptosis.

Practical (18 hrs)

1. Identification of different stages of mitosis and study of morphology of metaphase chromosomes from Onion root meristems (Recorded by photomicrographs).
2. Identification of different stages of meiosis from suitable plant material (Recorded by photomicrographs).

3. Microscopic observation (Chloroplast).
5. Study of mitotic index from suitable plant material.

References

1. Gerald Karp (2014). *Cell Biology* (VII Edn). Wiley.
2. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons
3. George Plopper, David Sharp, Eric Sikorski (2015). *Lewin's Cells* (III Edn). Jones and Bartlett Learning.
4. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
5. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.
6. Geoffrey M Cooper, Robert E Hausman (2009). *The Cell: A molecular approach* (V Edn). Sinaeur.
7. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
8. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.
9. David E Sadava (2009). Cell biology: Organelle structure and function. CBS.

GENETICS (Theory: 27Hrs; Practical: 18 Hrs)

Module 1: Genetics - From "Factors" to "Genes" and gene interactions (6 hrs)

Introduction to Mendelian genetics and principles of inheritance; Extensions of Mendelism (Brief study).Model organisms in Genetics - *Arabidopsis thaliana*, *Neurospora crassa*, *E. coli*, *Drosophila melanogaster* and *Caenorhabditis elegans* (Brief study).Linkage, crossing over and chromosome mapping in eukaryotes. Cytoplasmic inheritance, multiple alleles,quantitative inheritance, QTL; Penetrance and expressivity, Sex determination in plants and animals, X-chromosome inactivation in mammals – dosage compensation.

Module 2: Human Genetics and Cancer (9 hrs)

Inheritance of traits in Humans - Pedigree analysis(Nail Patella Syndrome and ABO locus) , genetic disorders in humans - autosomal recessive - ADA deficiency, Sickle cell anemia; autosomal dominant - Huntington's chorea, familial hypercholesterolemia; inborn errors of metabolism - phenylketonuria, Alkaptonuria, Albinism. Cancer - a genetic disease; Cancer and cell cycle, oncogenes, chromosome rearrangements and cancer (Philadelphia Chromosome), Tumour suppressor genes, causes of cancer, properties of cancer cells, types of cancer, Genetic pathways to cancer

Module 3: Mutations (4 hrs)

Classification and types: Chromosomal mutations - changes in structure and number; Gene mutations, Effect of different mutagens on the structure of DNA.

Module 4: Population Genetics (8 hrs)

Emergence of evolutionary theory and population genetics; Concepts in population genetics - Gene pool, Gene frequency, genotype frequency; Hardy Weinberg's Law and its applications; Exceptions to Hardy-Weinberg's Principle; Factors affecting gene frequency - Mutation, selection, migration, natural selection and Genetic drift (Bottle neck effect and Founder effect); Populations in Genetic equilibrium - balancing selection, mutation-selection balance, mutation drift balance. Speciation - pre-zygotic and post-zygotic isolation (Brief account); modes of speciation - Allopatric, sympatric and parapatric.

Practical (18 Hrs)

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis, Cytoplasmic Inheritance, Multiple alleles and quantitative inheritance.
2. Work out problems in population genetics-gene and genotype frequency, Hardy-Weinberg equilibrium.

References

1.Benjamin Lewin (2000). *Genes VII*. Oxford university press.

2. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.

3. Gardner E J, Simmons M J, Snustad D P (1991). *Principles of Genetics* (III Edn). John Wiley and Sons Inc.

4. Klug W.S., Cummings, M.R., Spencer, C.A and Palladino, M.A (2010). *Concepts of Genetics* (10th Edition). Pearson Education Limited.

5. Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.

6. Robert J Brooker (2009). *Genetics: Analysis and principles* (III Edn). McGraw Hill.

6. Strickberger (2005). *Genetics* (III Edn). Prentice Hall of India Pvt. Ltd.

8. William S Klug, Michael R Cummings (1994). *Concepts of Genetics*. Prentice Hall.

PLANT BREEDING (Theory: 18 Hrs; Practical 9 hrs)

Module 1: Introduction (2 hrs)

Objectives of plant breeding, important achievements and future prospects. Domestication and centers of origin of cultivated plants.

Module 2: Hybridization (3 hrs)

Hybridization-role and methods, inter-varietal, inter-specific and inter-generic crosses. Incompatibility and male sterility in plant breeding (brief account). Back-cross breeding. Heterosis, inbreeding depression.

Module 3: Idiotype breeding (2 hrs)

Role and methods, applications of idiotype breeding.

Module 4: Breeding for resistance (3 hrs)

Breeding for biotic (disease) and abiotic (drought) stresses; loss due to diseases, disease development, disease escape, disease resistance, vertical and horizontal- resistances of biotic stress; methods of breeding for disease resistance.

Module 5: Mutation breeding (6 hrs)

Mutagens and crop improvement. Spontaneous and induced mutations, effects of mutation. Physical and chemical mutagens; principles and working of gamma gardens, methods of mutation breeding, mutations in oligogenic traits, mutations in polygenic traits, limitations of mutation breeding, achievements of mutation breeding.Role of mutation in plant breeding.

Module 6: Modern breeding methods (2 hrs)

Modern trends in plant breeding: Tissue culture technologies (DNA marker-assisted Selection (MAS) - a brief study only).

Practical: (9 Hrs)

1. Hybridization techniques in self and cross pollinated plants.
2. Estimation of pollen sterility through in-vitro germination/staining-technique.
3. Visit a Plant Breeding station to familiarize with breeding programmes. Submit a report of the visit.

References

1. Allard R. W. (1995). *Principles of Plant Breeding*. John Wiley and Sons, Inc.
2. Denis Murphy (2007). Plant Breeding and Biotechnology. Cambridge University Press.
3. Ghahal G. S. and Gosal S. S. (2002). *Principles and procedures of Plant Breeding*. Narosa Publishing House.
4. Izak Bos and Peter Caligari (2007). Selection methods in plant breeding. Springer.
5. Kang M.S. (2002). Quantitative Genetics, Genomics and Plant Breeding. CABI.
6. Langridge P., K. Chalmers, Horst Lörz and Gerhard Wenzel (2005). Molecular Marker Systems in 7. Plant Breeding and Crop Improvement. Springer-Verlag.
8. Sharma J. R. (1994). *Principles and practices of Plant Breeding*. Tata McGraw-Hill Publishers Company Ltd.
9. Shukla.R.S. and P.S.Chandel (1974). Cytogenetics, Evolution, Biostatistics and Plant Breeding. S.Chand and Company Ltd. New Delhi.
10. Singh B. D. (1996). *Plant Breeding: Principles and methods*. Kalyani Publications.

BY010203: PLANT PHYSIOLOGY AND BIOCHEMISTRY
(Theory 45+27 =72 Hrs; Practical 36+27=63 Hrs; Credits: 4)

PLANT PHYSIOLOGY (Theory: 45 Hrs; Practical: 63 Hrs)

Module 1: Transport and Translocation of water and solutes (8 hrs)

(a) Absorption and translocation of water, apoplast and symplast, pathways of water uptake and transport, xylem transport, passive and active transport. Aquaporins. Water pathway in the leaf – driving force of transpiration, leaf anatomy for regulating transpiration. Stomatal biology – light dependent stomatal opening. Soil-plant-atmosphere continuum.

(b) Absorption of minerals: Soil characters influencing nutrient availability – size and charge of soil particles, soil pH. Mechanism of entry of minerals into roots.

(c) Transport of ions, solutes and macromolecules: Electrical properties of membranes, Membrane potential. Transport across cell membranes: Passive – diffusion, facilitated diffusion, membrane channels; plasmodesmata, porins, ion channels – gated channels, structure and working of K^+ ion channels. Active transport: Carrier proteins; P-type H^+ ATPase, ABC transporters.

Module 4: Photosynthesis (12 hrs)

(a) Light harvesting complexes: PS I, PSII; Structure and composition of reaction centers. Basic principles of light absorption, excitation energy transfer, mechanism of electron transport, photooxidation of water, proton electrochemical potential – photophosphorylation.

(b) Structure and function of RuBisco, CO_2 fixation – Calvin cycle. Photorespiration, role of photorespiration in plants. CO_2 concentrating mechanisms – algal and cyanobacterial pumps, C4 cycle, CAM pathway. Synthesis of starch and sucrose, photosynthetic quantum yield and energy conversion efficiency. Transport of photoassimilates – phloem loading and unloading, mechanism of phloem translocation – pressure flow. Thylakoid ET inhibitors, Photoinhibition and its tolerance mechanism.

Module 5: Respiration (10 hrs)

Three stages of respiratory metabolism (brief study only). Plant mitochondrial electron transport and ATP synthesis – organization of electron transfer complexes (complex I – IV). ATPase (Complex V) – detailed structure of F1 and Fo subunits, binding change mechanism of ATP synthesis. Comparison of mitochondrial and chloroplast ATP synthesis. Cyanide resistant pathway - alternative oxidase, its regulation and significance. Rotenone-insensitive pathway in plants.

Module 6: Nitrogen metabolism: (4 hrs)

N cycle. N fixation processes. Biological N fixation – structure of nitrogenase complex, reduction of N. Symbiotic N fixation – nodule formation, nodulin gene and nodulation genes, leghaemoglobin. Nitrate and ammonium assimilation. Transport of amides and ureides.

Module 7: Stress physiology (4 hrs)

Plant stress - biotic and abiotic. Stress sensing mechanisms in plants. Acclimation and adaptation mechanisms in plants.

Module 8: Sensory photobiology (4 hrs)

Plant photoreceptors - phytochromes, cryptochromes and phototropins, their function and mechanism of action. Photoperiodism and biological clocks – circadian rhythms. Floral induction and development.

Module 9: Plant growth regulators (3 hrs)

Physiological effects and mechanism of action of plant growth hormones. Role of elicitors in growth regulation.

Practical (36 hrs)

1. Measurement of Photosynthesis - Hill Reaction.
2. Estimation of proline in plant tissues under various abiotic stresses.
3. Estimation of phenol in plant tissues affected by biotic stress.
4. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.
5. Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon.
6. Determination of osmotic potential by tissue weight method.
7. Separation of photosynthetic pigments by TLC/paper chromatography and calculating the Rf value
8. Demonstration of amylase activity and GA effect in germinating cereal seeds.
9. Estimation of total chlorophyll and study of absorption pattern of chlorophyll solution.
10. Separation and collection of leaf pigments by silica gel column chromatography.
11. Determination of nitrate reductase activity.
12. Extraction and estimation of leghaemoglobin from root nodules.

References

1. Lincoln Taiz, Eduardo Zeiger, Ian Max Moller, Angus Murphy (2015). Plant Physiology and development (VI Edn). Sinaeur Associates, Inc. Publishers.
2. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinaeur Associates, Inc. Publishers.
3. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and molecular biology of plants*. L K International Pvt. Ltd.
4. Reginald H Garrett, Charles M Grisham (2005). *Biochemistry*. Thomson Brooks/Cole
5. H Robert Horton, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour (2002). *Principles of Biochemistry* (III Edn). Prentice Hall.
6. Frank B Salisbury, Cleon W Ross (1992). *Plant Physiology* (IV Edn). Wadsworth Publishing Company.
7. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
8. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
9. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.

10. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford
11. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
12. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS
13. S Sadasivam, A Manickam (1996). *Biochemical methods* (II Edn). New age international Publishers.

BIOCHEMISTRY (Theory: 27 Hrs; Practical 27 Hrs)

Module 1: Introduction (2 hrs)

Acid and Bases, ionisation of water, dissociation of acids, Henderson-Hasselbalch equation, pKa. Buffers - Common buffers (acetate, citrate and phosphate), buffer action, buffer capacity. Measurement of pH.

Module 2: Carbohydrates (4 hrs)

General structure and biological importance of carbohydrates. Monosaccharids and Oligosaccharides: classification and structure with common examples. Polysaccharides: Classification, structure and functions - starch, cellulose. Glycoproteins and glycolipids.

Module 3: Lipids (5 hrs)

(a) Classification, important biological functions. Structure of fatty acids, triglycerides, waxes, Phosphoglycerides and Sterols. Lipids with biological specific activities – steroids and isoprenoids. (b) Lipid metabolism in oilseeds – Oxidation of fatty acids, glyoxylate cycle, gluconeogenesis.

Module 4: Amino acids and proteins (5 hrs)

Classification and structure of aminoacids, peptide bond. Structure and functions of protein – primary, secondary, tertiary and quaternary structure. Ramachandran plot, alpha helix and beta conformations. Protein degradation in cells (brief account).

Module 5: Enzymes (7 hrs)

(a) Classification and naming, IUB system.
(b) Mechanism of enzyme action. Measurement and expression of enzyme activity, factors affecting enzyme activity.
(c) Enzyme kinetics - Michaelis-Menten kinetics, Lineweaver-Burk plot.
(d) Regulation of enzyme activity. Enzyme inhibition
(e) Co-enzymes and co-factors, Ribozymes and Abzymes.
(f) Enzyme technology - isolation and purification of enzymes, modifying enzymes for stability (brief study).

Module 6: Secondary metabolites (4 hrs)

Classification, Biosynthesis and functions of terpenoids, alkaloids and phenolics.

Practical (27 Hrs)

1. Preparation of buffers-Citrate and Phosphate-various strengths.
2. Quantitative estimation of reducing sugar.
3. Separation of amino acids by TLC.
4. Quantitative estimation of protein (Lowry's method).

5. Preparation of Molar, Normal, Percentage and PPM solutions and their dilutions
6. Estimation of total phenolics in plant tissue
7. Isolation and estimation of amylase from germinating seeds.

References

1. Jeremy M Berg, John L Tymoczko and Lubert Stryer (2012). Biochemistry (VII Edn). W H Freeman
2. David L Nelson, Michael M Cox (2013). Lehninger Principles of Biochemistry (VI Edn). Macmillan International.
3. T A Brown (2018). Biochemistry. Viva Books.
4. Arti Nigam, Archna Ayyagari. Lab Manual in Biochemistry Immunology and Biotechnology (2007) Tata McGraw Hill Pvt. Ltd.
5. Bob B Buchanan, Wilhelm Gruissen and Russel L. Jones (2000). Biochemistry and Molecular Biology of plants. IK International Pvt. Ltd.
6. Donald Voet, Judith Voet (2011) Biochemistry. John Wiley and sons Inc.
7. David L Nelson and Michael M Cox. Principles of Biochemistry
8. David T Plummer (1998) An Introduction to practical Biochemistry
9. Keshav Trehan Biochemistry. New Age International.
10. Sadasivam S and Manickan. Biochemical Methods. New Age International.
11. Satyanarayana U and Chakrapani U Biochemistry (2011).
12. Rastogi S C Biochemistry (2010) Tata McGraw Hill.

BY010204: MOLECULAR BIOLOGY
(Theory 54 hrs; Practical 18 hrs; Credits: 3)

Module 1: Nucleic acids (6 hrs)

(a) Molecular structure of DNA: Watson and Crick model, alternative conformations, DNA triplex and quadruplex, imotif. DNA supercoiling – Topoisomerases.

(b) Structure, Diversity and Versatility of RNA: Primary, secondary, tertiary and quaternary structure of RNA. RNA as genetic material – plus, minus, double stranded RNA. Catalytic RNA: Ribozymes – Discovery, structure, mechanism and functions; HDV ribozyme, hammerhead ribozymes, self-splicing introns, RNaseP, RNase MRP, Peptidyl transferase. Noncoding RNA: Structure and biological roles of rRNA, tRNA, tmRNA, siRNA miRNA, piRNA, lncRNA (Xist, HOTAIR) and circular RNA.

Module 2: Organization of the Genome (4 hrs)

(a) Genome organization in viruses, bacteria, and eucaryotes. Organellar genome – structure and organization, important organellar genes.

(b) Eucaryotic nuclear genome: c-value paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA – mini- and microsatellites.

Module 3: Replication of the Genome (6 hrs)

(a) RNA replication: By RNA-dependent RNA polymerase, retroviral RNA replication.

(b) DNA replication: Unit of replication, enzymes and proteins involved in replication (in both procaryotes and eucaryotes). Structure of the replication origin (in both procaryotes and eucaryotes), priming (in both procaryotes and eucaryotes), replication fork, fidelity of replication. Process of replication – initiation, elongation and termination. Replication in the telomere - telomerase.

Module 4: Gene Expression (15 hrs)

(a) Gene: Concept of gene; structural and genetic definitions – complementation test.

(b) Transcription in procaryotes: Initiation – promoter structure, structure of RNA polymerase, structure and role of sigma factors. Elongation – elongation complex, process of RNA synthesis. Termination – rho-dependent and rho-independent termination.

(c) Transcription in eucaryotes: Types, structure and roles of RNA polymerases. Promoters – important features of class I, II, & III promoters. Enhancers and silencers. General transcription factors and formation of pre-initiation complex. Elongation factors, structure and function of transcription factors.

(d) Post-transcriptional events: Split genes, splicing signals, splicing mechanisms of group I, II, III, and tRNA introns. Alternative splicing, exon shuffling, *cis*- and *trans*-splicing. Structure, formation and functions of 5' cap and 3' tail of mRNA, RNA editing, mRNA export.

(e) Genetic code: Important features of the genetic code, proof for the triplet code, Exceptions to the standard code.

(f) Translation: Important features of mRNA – ORF, RBS. Fine structure, composition and assembly of procaryotic and eukaryotic ribosomes. tRNA charging, initiator tRNA.

(g) Stages in translation: Initiation – formation of initiation complex in procaryotes and eucaryotes, initiation factors in procaryotes and eucaryotes, Kozak sequence. Elongation – process of polypeptide synthesis, active centers in ribosome - 3-site model, peptidyl transferase, elongation factors. Termination – process of termination, release factors, ribosome recycling.

(h) Protein sorting and translocation: Cotranslational and posttranslational – signal sequences, SRP, translocon. Membrane insertion of proteins. Post-translational modification of proteins. Protein folding – self assembly, role of chaperones in protein assembly.

Module 5: Control of Gene Expression (10 hrs)

(a) Viral system: Genetic control of lytic and lysogenic growth in λ phage, lytic cascade.

(b) Procaryotic system: Transcription switches, transcription regulators. Regulation of transcription initiation; Regulatory proteins - activators and repressors. Structure of *Lac* operator, CAP and repressor control of *lac* genes. Regulation after transcription initiation – regulation of amino acid biosynthetic operons - attenuation of trp operon, riboswitches.

(c) Eucaryotic system: Changes in chromatin and DNA structure – chromatin compaction, mechanism of action of activators and repressors, gene amplification, gene rearrangement, alternate splicing, gene silencing by heterochromatization, and DNA methylation. Effect of regulatory transcription factors on transcription. Post-transcriptional control – mRNA stability. Small RNA mediated control.

Module 6: Recombination (5 hrs)

Homologous and nonhomologous recombination, molecular mechanism of homologous recombination. Site-specific recombination, transposition - types of transposons.

Module 7: Epigenetic inheritance (4 hrs)

Genomic imprinting, Cytosine methylation, Histone code, ncRNA and epigenetics

Module 8: Mutation repair (5 hrs)

DNA repair mechanisms: Direct repair, Excision repair – base excision repair and nucleotide excision repair. Mismatch repair, Recombination repair – homologous recombination repair, nonhomologous end joining, SOS response – Transletion DNA polymerase.

Practical (18 hrs)

1. Work out problems based on DNA structure, replication, gene expression and genetic code (Genetic code chart may be brought for reference during examination).

References

1. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2018). *Lewin's Genes XII*. Jones and Bartlett Publishers.
2. James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine, Richard Losick (2017). *Molecular biology of the gene* (VII Edn). Pearson.
3. S B Primrose, R M Twyman (2010). Principles of gene manipulation and Genomics (VII Edn). Blackwell Publishing.
1. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.
2. Geoffrey M Cooper, Robert E Hausman (2009). *The Cell: A molecular approach* (V Edn). Sinaeur.
3. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
4. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2000). *Molecular cell biology* (IV Edn). W H Freeman & Company.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
6. Robert J Brooker (2009). *Genetics: analysis and principles* (III Edn). McGraw Hill.
8. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and Molecular biology of plants*. I K International Pvt. Ltd.
9. Daniel L Hartl, Elizabeth W Jones (2012). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
11. William S Klug, Michael R Cummings (2004). *Concepts of Genetics* (VII Edn). Pearson.
12. Daniel J Fairbanks, W Ralph Anderson (1999). *Genetics: The continuity of life*. Brooks/Cole publishing company.
13. Robert F Weaver (2002). *Molecular biology* (II Edn). McGraw Hill.

14. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.
15. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics from genes to genomes* (II Edn). McGraw Hill.
16. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
17. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
18. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford.
19. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman & company.
20. David P Clark (2010). *Molecular biology*. Elsevier.
21. David R Hyde (2010). *Genetics and molecular biology*. Tata McGraw Hill.
22. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
23. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
24. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
25. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2012). *Introduction to genetic analysis*. W H Freeman & Company.
26. T A Brown (2002). *Genomes* (II Edn). Bios.
27. Robert H Tamarin (2002). *Principles of genetics*. McGraw Hill.
28. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS.
29. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology* (III Edn.). Garland Science.
30. Pranav Kumar, Usha Mina (2011). *Biotechnology: A problem approach*. Pathfinder Academy.
31. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
32. Lynne Cassimeris, Viswanath R Lingappa, George Plopper (Eds) (2011). *Lewin's Cells* (II Edn). Jones and Bartlett Publishers.

MODEL QUESTION PAPERS– THEORY

M Sc Botany Degree (CSS) Examination

II Semester

Faculty of Science

BY010201: PLANT ANATOMY, DEVELOPMENTAL BIOLOGY AND HORTICULTURE

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is meant by Abiogensis?
2.Write brief notes on
a) Moleculae clock b) Eras

3. Describe the economic importence of Plant fibers.
4.Describe the structure and fuction of wood parenchyma.
5.Describe the horticultural implement used for weeding.
6. What is double fertilization?
7. What is tension wood?
8. Describe different parts of stem apex.
9. What is meant by collateral and open vascular bundle?
10. Define hydrophytes. Give any two anatomical characters.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11.Write a note on evolutionary time – scale?
12. Describe the structure and development ofstomata.
13. What is Krantz anatomy? Mention its significance.
14.Write a brief note on the following:
(a) Apomixis (b) Polyembryony (c) Xenia
15. What are the developmental changes in shoot apex leading to floral induction?
16. Write a brief note on different type of gardening.
17. What is meant by genetic drift?
18. What is pagoda?

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe various theories to explain the meachanism of evolution.
20. With suitable example and illustration describe various anomalous primary and secondary structure in the stem of angiosperms.
21.Write an essay on olericulture.
22. Write an essay on morphogenesis and organogenesis in plants.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
II Semester
Faculty of Science
BY010202: CELL BIOLOGY, GENETICS AND PLANT BREEDING
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is apoptosis?
2. Write a brief description on cell adhesion molecules.
3. What are the functions of telomere?

4. What is the genetic significance of the fact that gametes contain half the chromosome complement of somatic cells?

5. Differentiate between heterochromatin and euchromatin.

6. Explain the relationships between the following pairs of genetic terms:

(a) Genotype and phenotype (b) Gene and trait (c) Allele and gene (c) Gene and chromosome

7. What causes phenylketonuria?

8. What is dosage compensation?

9. What causes inbreeding depression?

10. Differentiate between vertical and horizontal resistance.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Draw the diagram of a bivalent chromosome and label the following parts: centromere, sister chromatids, nonsister chromatids, homologous chromosomes, and chiasma.

12. Describe the self-assembly and the dynamic structure of cytoskeletal filaments.

13. Describe the endosymbiont hypothesis on the origin of chloroplast and mitochondria.

14. Quoting suitable examples, explain genetic drift.

15. Write an account on tumor-suppressor genes.

16. Describe the structure and functions of glyoxysomes and peroxisomes.

17. Explain the concept, "Centres of origin."

18. Describe the methods used for breeding disease resistance in plants.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe the chemical composition, structural organization and the dynamic nature of plant cell membrane.

20. What are cell-cycle checkpoints? Describe the principal checkpoints in the cell cycle.

21. What is Hardy-Weiberg equilibrium? Describe the conditions for Hardy-Weinberg equilibrium.

22. Write an account on the modern trends in plant breeding.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
II Semester
Faculty of Science
BY010203: PLANT PHYSIOLOGY AND BIOCHEMISTRY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Define the following;
(a) Km (b) pKa (c) Vmax (d) Kw
2. What are isozymes?
3. Derive Henderson-Hasselbalch equation
4. Classify monosaccharides based on the number of C atoms.
5. What is RQ? Give the RQ for different substrates
6. Given an account of the role of Gibberellins
7. What is the membrane potential and how is it generated?
8. What is the role of the antenna complex in the light-dependent reactions of photosynthesis?
9. What is the function of leghemoglobin during Nitrogen fixation?
10. What are ABC transporters?

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write a brief account on the different methods of regulation of enzyme activity
12. Describe the following terms which are related to protein structure;
(a) Quaternary structure (b) α-helix (c) Peptide unit (d) Hydrogen bonds
13. Describe buffer action citing suitable examples
14. Write brief descriptions on;
(a) Aquaporin (b) Active transport (c) Light harvesting complexes (d) Glycolysis
15. Explain the mechanism of electron and proton transport in the thylakoid membrane
16. Write an account on soil-plant-atmosphere continuum.
17. Explain the rotenone-insensitive pathway in plants.
18. Describe the mechanism of entry of minerals into the roots of plants.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. What is Ramachandran plot? Describe the structural details and principles based on which Ramachandran plots are constructed. Add a note on its applications.
20. With the help of a diagram, describe the detailed structure of ATPase complex. Write the binding change mechanism of ATP synthesis.
21. What are the stresses to which plants are commonly exposed? Describe the stress tolerance mechanisms found in plants.
22. Compare and contrast between C3 and C4 photosynthesis.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
II Semester
Faculty of Science
BY010204: MOLECULAR BIOLOGY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. In what sense does attenuation provide a "fine tuning" mechanism for operons that control amino acid biosynthesis?
2. Describe the function and importance of the 3' to 5' exonuclease activity of DNA polymerases
3. Explain the opposite polarity of the double stranded DNA.
4. What is SRP?
5. Explain the role of the following enzymes/proteins;
(a) Rho protein (b) Sigma factor (c) Gyrase (d) Tus protein
6. What is histone code?
7. Explain the function of translation polymerase.
8. Comment on the role of chaperones in protein assembly.
9. What is ARS?
10. 'Ribosome is a ribozyme'. Comment.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Describe the experimental methods used to crack the complete genetic code.
12. Describe the phenomenon of RNAi? How is RNAi involved in gene regulation?
13. Describe the genetic control of the entry of a Lambda phage into lytic or lysogenic growth.
14. Write briefly on the following;
(a) Shine-Dalgarno sequence (b) Kozak sequence (c) Amber codons (d) DNA quadruplex
15. What are transposons? Write a brief account on the types of transposons.
16. Write a brief account on ribozymes.
17. What are the functions of miRNA?
18. Describe how telomerase help maintain the structure of telomere.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe the various modifications that the eukaryotic pre-mRNA usually undergoes.
20. Compare the following;
(a) Eucaryotic and prokaryotic promoters (b) Eucaryotic and prokaryotic Ribosomes (c) Eucaryotic and prokaryotic RNA polymerases (d) Eucaryotic and prokaryotic DNA polymerases
21. Write a comparative account of the molecular events taking place in the 5' – 3' synthesis of RNA during transcription and the 5' – 3' synthesis of DNA during the replication of DNA.
22. Describe the different methods of control of gene expression in eucaryotes.

(2 x 5 = 10)

MODEL QUESTION PAPERS – PRACTICAL

SEMESTER II - PRACTICAL COURSE I

BY010205: ANATOMY, DEVLOPMENTAL BIOLOGY, HORTICULTURE, CELL BIOLOGY, GENETICS AND PLANT BREEDING

Time: 4 hours **Weightage: 30**

1. Make suitable micropreparation of specimen A. Draw diagrams, identify giving reasons.
(Total weight 3.5 = Preparation – 1, Identification with reasons – 1.5, Diagram – 1)
2. Describe and compare the stomatal type in the materials B and C.
(Total weight 3 = Identification of stomatal types with reasons – 1 x 2, Comparison – 1)
3. Describe the nodal feature of the material D.
(Total weight 2 = Identification of nodal type – 1, Description – 1)
4. Dissect embryo from the given seeds E.
(Weight = 1.5)
5. Write critical notes on F.
(Weight = 1.5)
6. Demonstrate _____ grafting/layering in material G.
(Weight = 2)
7. Prepare a smear of the given anther F and identify any two stages of meiosis I.
(Total weight 2.5 = Preparation – 1, Identification with reasons – 1, Diagram – 0.5; 2 x 2.5 = 5)
8. Workout the problems H and I.
(Weight = 3; 2 x 3 = 6)
9. Estimate pollen sterility in the given sample J.
(Total weight 1.5 = Working – 1, Calculation – 0.5)
10. Practical record
(Weight = 4)

Key to the questions:

1. A – Stem showing anomalous growth, prescribed in the syllabus.
2. B, C – Leaves having distinct types of stomata
3. D - Nodal segments having type of node specified in the syllabus
4. E - Seeds with young embryos – maximum credit for earliest stages
5. F - Permanent slide/Photograph of embryo types, polyembryony, endosperm types, pollen grains, anther developmental stages, types of ovules etc.
6. G – Whip and Tongue, Approach, Wedge, and air layering.
7. H - Supply fresh flower buds of *Rhoeo* or *Chlorophytum.*
8. H, I - Problems related to Linkage mapping and population genetics.
9. J – Germination method
10. Awarding 'A grade' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly.This also includes field study report(s)/Lab visit report(s), if any.

SEMESTER II - PRACTICAL COURSE II

BY010206: PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY

Time: 4 hours **Weightage: 30**

1. Conduct the experiment A
(Total weight 9 = Principle, procedure and graph, if any – 3, Working – 4, Result – 1, Comments/Interpretation – 1)
2. Assay of amylase enzyme from germinating seeds/Appropriate plant material B.

Or
Estimate the amount of protein in the given sample B using Lowry's method
(Total weight 9 = Principle and procedure – 2, Preparation of standard graph – 3, Working – 2, Calculation – 1, Result – 1)
3. Comment on C and D.
(Total weight 3; 1. 5 x 2 = 3)
4. Work out problems E and F.
(Weight 3; 2 x 3 = 6)
4. Practical record
(Weight = 3)

Key to the questions:
1. A – Draw lots from the list of physiology experiments provided. A minimum of 5 experiments from the list should be included in the lots.
2. B – Draw lots; Students are expected to do the complete experiment, preparation of standard graph, preparation of extract on their own. Give the tissue, sample and reagents necessary. Supply stock solution only for the preparation of standard graph.
3. C, D – Reagents, chemicals
4. E, F – Problems related to DNA structure/replication/gene expression/genetic code. Students are allowed to bring a copy of genetic code chart showing codons and corresponding amino acids.
4.Awarding 'A grade' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly.This also includes field study report(s)/Lab visit report(s), if any.

List of plant physiology experiments (Question 1)
1. Separate pigments of the given leaf sample by column chromatography. Collect the pigment fragments and submit. Comment on the result.
2. Separate amino acids by TLC and identify _____
3. Determine the osmotic potential of the given plant tissue from the values corresponding to change in weight of the tissue. Comment on the result.
4. Estimate the proline content in the control (e.g., seeds germinated in fresh water) as well as the treated (e.g., seeds germinated in 50mM NaCl) sample. Comment on the result.
5. Estimate the phenol content in plant tissues affected by biotic stress and compare the same with non affected portions. Comment on the result.
6. Determine peroxidase activity in plant tissues affected by biotic/abiotic stresses. Comment on the result.
7. Estimate free amino acids in senescing leaves and compare the same with young leaves. Comment on the result.
8. Estimate the total chlorophyll in shade leaves and sun leaves and comment on the result
9. Estimate the leghaemoglobin in the root nodules

SEMESTER III

THIRD SEMESTER COURSES

BY010301	RESEARCH METHODOLOGY, MICRO-TECHNIQUE, BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION
BY010302	BIOTECHNOLOGY, BIOINFORMATICS AND BIO-NANOTECHNOLOGY
BY010303	ANGIOSPERM TAXONOMY,ECONOMIC BOTANY AND ETHANOBOTANY
BY010304	ENVIRONMENTAL SCIENCE
BY010305	RESEARCH METHODOLOGY MICROTECHNIQUE, BIOSTATISTICS, BIOPHYSICS AND BIOTECHNOLOGY NAD BIOINFORMATICS PRACTICAL
BY010306	ANGIOSPERM TAXONMY, ECONOMIC BOTANY AND ENVIRONMENTAL SCIENCE PRACTICAL

Total Credits: 19
Total Hours: 450

BY010301: RESEARCH METHODOLOGY, MICROTECHNIQUE,BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION

(Theory: 18+18+18+18= 72 Hrs; Practicals: 09+27+09+18 = 63Hrs) Credits:4

RESEARCH METHODOLOGY (Theory: 18 Hrs)

Module 1: Introduction (3 hrs)

Need for research, objectives of research, types of research, stages of research; generation of a research problem, execution of work; interpretation of results: Analysis of data, interpretation and conclusions. Research ethics. Intellectual property rights (IPR): Copy right and patenting-*Brief account*.

Module 2: Review of literature (6 hrs)

Library: Structure of a Scientific Library, Journals (Current and Back-volumes), Books.
Catalogue: Types of catalogues- card catalogue, computerized catalogue.Classification of books (Universal decimal system). Journals: indexing journals, abstracting journals, research journals, review journals, e- journals. Impact factor of journals; h-Index; NCBI, PubMed, Medline. Other sources of references:reprints-acquisition and filing.Internet, open access initiative, INFLIBNET, INSDOC, N-list and Shodhganga. Preparation of index cards: author index and subject index. Open source bibliography. Management system, citation management tools (*E.g.Mendeley, EndNot*).

Module 3: Preparation of project report and Dissertation/Thesis (3 hrs)

Project report. Dissertation/Thesis: Selection of problem and its relevance; available information collected; Execution of experimental programmes; Writing dissertation (*IMRAD-System*): General Format; General principles in writing: Preliminary pages - title page, certificates, acknowledgements, and contents page. Main text of the Dissertation/Thesis: title, introduction, review of literature, material(s) and method(s), heading(s), result(s): table(s) and illustration(s), marginal indicator(s), caption(s), camera ready copy; discussion, summary and conclusion; references, abstract(s) and appendix.

Module 4: Preparation of Project Proposals,Presentation and Publication of Research Outcomes (6 hrs)

(a) Preparation of project proposal:title, introduction, literature review and abstract; aim and scope; present status; location of experiments; materials and methods; justification; expected outcome; date of commencement; estimated date of completion; estimated cost; references; funding agencies.
(b) Presentation and publication of research outcomes:
(i) Statistical analysis by using software (*Eg: - SPSS*).(ii) Preparation of research paper and short communications.(iii) Preparation of review articles.(iv) Proofreading-standard abbreviations for proof correction. (v) Presentation of Research findings in Seminars and Workshops.

Practical (9 Hrs)

1. Visit a scientific library or documentation center and submit a report.
2. Prepare a project proposal.
3. Prepare an outline of dissertation and research paper.
4. Prepare a list of references.

References

1. Anderson J., Durston B. H. and Poole (1970). *Thesis and assignment writing*. Wiley eastern.
2. Bedekar V. H. (1982). *How to write assignment and research papers, dissertations and thesis*.
3. Bercy R. (1994). *The research project, how to write it*. Rutledge, London.
4. Clifford Hawkins and Marco Sorghi. *Research: How to plan and speak about it and write about it*. Narosa Publishing Company.
5. Day R. A. (1979). *How to write and publish a scientific paper*. Cambridge University press.
6. Joseph Gibaldi (2000 & 2009). *MLA- Handbook for writers of research papers*. Affiliated East-West Press Pvt.Ltd, New Delhi.
7. Judith Bell. *How to complete your research project successfully*. UBS Publishers and Kanak publications.
8. Krishnakumar K. (1981). *An introduction to cataloguing practice*. Vikas Publishing house.
9. Parshar R. G. (1989). *Index and indexing systems*. Me dallion press New Delhi.
10. Victoria E. McMillan (1997). *Writing papers in the biological sciences* (II Edn). Bedford books.
11. Vijay Upadhaya and Arvind Shende (2014). *Research methodology*. S. Chand and Company Pvt.Ltd. Newdelhi.

MICROTECHNIQUE (Theory: 18 Hrs)

Module 1: Killing and Fixing (3 hrs)

Principles and techniques of killing and fixing; properties of reagents, fixation images; properties and composition of important fixatives - Carnoy's Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle- Erliki fluid.

Module 2: Dehydration, Clearing, Embedding and Sectioning (5 hrs)

Dehydration: Principles of dehydration, properties and uses of important dehydrating and clearing agents - alcohols, acetone, xylol, glycerol, chloroform, dioxan. Dehydration Methods: (i) Tertiary-butyl alcohol method. (ii) Alcohol-xylol method. Embedding: Paraffin embedding. Sectioning: Free hand sections – Prospects and problems; sectioning in rotary microtome, sledge microtome and cryotome.

Module 3: Staining (5 hrs)

Principles of staining; classification of stains, protocol for preparation of; (i) Natural stains - Haematoxylin and Carmine (ii) Coal tar dyes – Fast green, Orange G, Safranine, Crystal violet, Cotton Blue and Oil Red O.Techniques of staining: (i) Single staining; Staining with Safranine or crystal violet. Double staining; Safranine-Fast green method, Safranine-Crystal violetmethod.Triple staining; Safranine-Crystal Violet-Orange G method. Histochemical localization of starch, lipid and lignin.

Module 4: Whole mounts (5 hrs)

Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method. Staining of whole mount materials (haematoxylin, fast green or Safranine-fast green

combination). Significance of whole mounts. Techniques of smear, squash and maceration.Mounting: Techniques, common mounting media used - DPX, Canada balsam,Glycerin jelly and Lacto phenol. cleaning, labeling and storage of slides.

Practical (27 Hrs)

1. Students are expected to be thorough with the following techniques.
   (a) Preparation of semi-permanent slides.
   (b) Preparation of permanent slides.
   (c) Preparation of whole mounts.
   (d) Maceration.
   (e) Preparation of fixatives (FAA, Carnoys'fluid).
   (f) Preparation of dehydration series (Alcohol, Acetone, TBA).
   (g) Preparation of paraffin blocks.
   (h) Preparation of serial sections.
2. Candidates should prepare and submit 10 permanent slides in which the followingcategories should be included:
   (a) Free hand sections (single/double stained).
   (b) Serial sections (single/double stained).
   (c) Wood sections and whole mounts.

References

1. Johanson D A (1940). *Plant microtechnique*. McGraw Hill co.
2. John E Sass (1967). *Botanical Microtechnique*. Oxford IBH Publ. Company.
3. Gray (1964). *Handbook of Basic Microtechnique*. McGraw Hill co.
4. Prasad M K, M Krishna Prasad (1983). *Outlines of Microtechnique*. Emkay Publications.
5. Geoffrey A Meek (1976). *Practical electron microscopy*. John Willey and sons.
6. Krishnamurthy K V (1987). *Methods in Plant Histochemistry*. S Viswanathan printers, Anand book depot, Madras.
7. Toji Thomas (2005). *Essentials of botanical microtechnique* (II Edn). Apex infotechpublishing company.

BIOSTATISTICS (Theory18 Hrs)

Module 1: Introduction to Statistics (4 hrs)

Basic principles and methods of Biostatistics: data collection, Primary and Secondary data. Tools for data collection and presentation. Measures of central tendency and dispersion.

Module 2: Probability, Correlation and Regression (5 hrs)

Probability - Definition, Mutually exclusive and Independent events. Binomial and Normal - distribution.Linear Regression and Correlation (*Simple and Multiple*).

Module 3: Design of experiments (4 hrs)

Experimental Designs: Principles -Replication, Randomization and Local control.Common designs in Biological experiments: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Factorial Design (FD).

Module 4: Tests of Significance (5 hrs)

Statistical Inference-Estimation-Testing of Hypothesis: - t-Test, Chi-square Test (Goodness of fit, Independence or Association, Detection of Linkages), F-test, ANOVA.

Practical (9 Hrs)

1. Test the significance of a given data using t-Test, Chi square -test.
2. Analysis of a set of data for Correlation / Regression (Scatter diagram).
3. Determine the probability for different types of events.

References

1. Chandel R. S. (1975). *A handbook of Agricultural statistics*. Achal prakashan Mandir.
2. Gomez K. A. and Gomez A. A. (1984). *Statistical procedures for agricultndural research*. John Wiley and sons.
3. Gupta S. P. (1984). *Statistical methods*. S Chand and company. New Delhi.
4. Panse V. G. and Sukathme P. V. (1995). *Statistical methods for Agricultural workers*. ICAR. New Delhi.
5. Panse.V.G. and P.V. Sulchatme (1995). *Statistical Method for Agricultural workers*. Indian Council of Agricultural Research, New Delhi.
6. Robert J. Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.
7. Shukla.R.S and P.S Chandel (1974). *Cytogenetics, evolution, Biostatistics and plant Breeding*. S. Chand and Comnpany Ltd. NewDelhi.
8. Thomas M. Little and F. Jackson Hills (1978). *Agricultural Experimentation*. Johnwiley and sons, Newyork.

BIOPHYSICAL INSTRUMENTATION (Theory 18 Hrs)

Module 1: Introduction to Microscopy (3 hrs)

Parts of Microscope, Principles of Microscopy.Types of Microscopes- Simple and Compound; Stereo Microscope, Phase contrast Microscope, Fluorescence Microscope. Electron Microscopy (Eg: TEM, SEM, and E-SEM-*Brief account*).

Module 2: Principles and Applications of Instruments (6 hrs)

Micrometry.Basic principles and applications of pH meter, colorimeter,UV–Visible spectrophotometer and centrifuges (E.g. Table top and ultra centrifuge). Flow cytometry.Immunoassay system-RIA and ELISA.Cryobiology- Lyophilisation and its applications.Auto radiography and Liquid Scintillation counter.

Module 3: Basic Principles and Applications of Chromatography (4 hrs)

Types of Chromatography**:** Paper, TLC, Column chromatography, ion exchange chromatography, GCMS, HPLC, HPTLC and LCMS.

Module 4: Basic principles and applications of Electrophoresis and Spectroscopy (5 hrs)

Electrophoresis: Agarose gel Electrophoresis, SDS PAGE, Pulse Field Gel Electrophoresis. Fluorescence, UV, IR, ORD, Visible, NMR, ESR, and Atomic Absorption.

Practical: (18 Hrs)

1. Micrometry; calibrate the ocular and stage micrometre on a light microscope and measure an object.
2. Calibrate the pH meter and measure the pH of different samples.

3. Estimate the concentration of the given sample using colorimeter or spectrophotometer.
4. Separate plant pigments by TLC or Column chromatography.

References

1. Ackerman E A, Ellis L E E, Williams L E (1979). *Biophysical Science*. Prentice-Hall Inc.
2. Chang R (1971). *Basic principles of spectroscopy*. McGraw Hill.
3. Pesce A J, Rosen C G, Pasty T L. *Fluorescence Spectroscopy: An introduction for Biology and Medicine*. Marcel Dakar.
4. Stanford J R (1975). *Foundation of Biophysics*. Academic press.
5. Henry B Bull (1971). *An Introduction to physical biochemistry*. F A Devis Co.
6. Perkampus H (1992). *UV-VIS Spectroscopy and its applications*. Springer-Verlag.
7. Garry D Christian, James E O'reilvy (1986). *Instrumentation analysis*. Alien and Bacon, Inc.
8. Friefelder D. *Physical Biochemistry*. W H Freeman and Co.
9. Mahadevan A, Sridhar R (1996). *Methods in Physiological Plant Pathology*. Sivakmi Publications.
10. Salle A J (1974). *Fundamental principles of Bacteriology*. McGraw Hill.

BY010302: BIOTECHNOLOGY, BIOINFORMATICS AND BIONANOTECHNOLOGY
(Theory 72 Hrs; Practical 36 Hrs; Credits: 4)

BIOTECHNOLOGY (54 hrs)

Module 1: Bioprocess Technology (5 hrs)

(a) Introduction to classical and modern biotechnology. Microbial biotechnology**:** Mode of operation of a bioprocess – basic concepts of batch, fed batch and continuous operation of a bioprocess.

(b) Basic design and construction of various types of bioreactors used in bioprocesses.

(c) Commercialproduction of metabolites using bioreactors. Submerged and solid state fermentation. Microbes in production of enzymes, antibiotics, biopolymers, bioethanol, organic acids, SCP.

Module 2: Plant tissue culture (12 hrs)

(a) Brief history and important milestones in plant tissue culture. Types of cultures: organized structures - meristem, shoot tip, node, embryo, root cultures; unorganized structures - callus, suspension and protoplast cultures. Cellular totipotency. Differentiation of cells in callus - tracheid formation, chloroplast differentiation. Factors influencing vascular differentiation. Organogenic and embryogenic differentiation.

(b) Culture protocol:General composition of the culture media; solid and liquid media – gelling agents. Preparation and standardization of MS medium for shoot and root differentiation. Sterlization of medium, glasswares, instruments, plant material, transfer area. Preparation of explants and inoculation, incubation. Pattern of growth and development, subculturing.

(c) Micropropagation:Methods – shoot tip and nodal segment culture, stages of micropropagation. Advantages and disadvantages of micropropagation. Applications of tissue culture.

Module 3: Genetic engineering (15 hrs)

(a) Important steps in Gene cloning:Basic principles of gene cloning.Isolation and purification of DNA from cells (Brief study). Isolation of DNA fragments of interest, creation of recombinant DNA – introduction into host cells, selection and screening of recombinants, propagation of recombinants.

(b) Tools and techniques: Restriction endonucleases, Ligases. Vectors – necessary properties of a vector, types of vectors based on origin; shuttle vectors, expression vectors.

(c) Plant transformation**:** *Agrobacterium tumefaciens* mediated gene transfer in plants - details of vector system based on *A. tumefaciens*, binary vector and cointegrate vector. Steps involved in *Agrobacterium* mediated gene transfer to plants. Plant transformation by direct transfer of DNA (Vectorless methods) - microprojectiles, electroporation, microinjection, chemical, lipofection.

(d) Applications of genetic engineering -in genetic studies, agriculture, and medicine (brief study citing specific examples)

Module 4: Genome editing (3 hrs)

Introduction, scope, methods and applications

Module 5: Advanced tools and techniques in Biotechnology (10 hrs)

(a) cDNA synthesis, artificial DNA synthesis – solid-phase synthesis.

(b) PCR - Procedure and applications, variants of PCR - Real time PCR and reverse transcriptase PCR and their applications.
(c) Automated DNA sequencing.
(d) *In vitro* mutagenesis, site directed mutagenesis.
(e) Blotting techniques - procedure and applications of southern, northern, western, and dot blotting. Microarray (gene chip) technology and its applications.
(f) Procedure and applications of DNA profiling, Footprinting.
(g) Procedure and applications of FISH and GISH

Module 6: Genomics (5 hrs)

Introduction to genome, genomics, transcriptomics and proteomics. Structural genomics - genome sequencing strategies. Genome annotation – structural and functional annotation, gene expression study using microarrays.

Module 7: Societal concerns with biotechnology (4 hrs)

Harm to the environment - potential impact of GMOs on the ecosystem; GM food – effect on health and environment. Misuse of modern molecular biology tools and techniques, bioweapons, bioterrorism. Ethical issues relating to rDNA techniques. Patents – issues relating to patenting living organisms, their genes and other bioresources.

BIOINFORMATICS (13 hrs)

Module 1:Methods, tools and applications of bioinformatics (3 hrs)

(a) Databases: Organization, primary and secondary databases. DNA sequence databases - Genbank, EMBL & DDBJ. Protein databases - SWISS-PROT, PDB. Sequence alignment: Significance; Global Alignment, pair wise analysis, Scoring Matrices (an introduction). Database similarity search – query sequence search; BLAST – Algorithm and different versions. FASTA. Multiple sequence analysis dynamic programming.
(b) Molecular Phylogeny: molecular clock hypothesis. Phylogenetic Trees, Terminology in Phylogenetic tree. Tree drawing Methods. Cladogram and Phylogram. Significance of Molecular Phylogeny.
(c) Structural Bioinformatics: Molecular structure viewing tool – Rasmol; Protein structure prediction – Secondary Structure prediction (Chou Fasman method), Tertiary structure prediction (Homology modeling).

Module 2 Advanced tools and techniques in Biotechnology (10 hrs)

(a) cDNA synthesis, artificial DNA synthesis – solid-phase synthesis. Construction of genomic and cDNA library.
(b) PCR - Procedure and applications, variants of PCR - Real time PCR and reverse transcriptase PCR and their applications.
(c) Automated DNA sequencing.
(d) *In vitro* mutagenesis, site directed mutagenesis.
(e) Blotting techniques - procedure and applications of southern, northern, western, and dot blotting. Microarray (gene chip) technology and its applications.
(f) Procedure and applications of DNA profiling, Footprinting.
(g) Procedure and applications of FISH and GISH

BIONANOTECHNOLOGY (5 Hrs)

Module 1: Introduction to nanoparticles and nanotechnology (3 hrs)

(a) An overview on concepts, strategies and tools. Types of nanoparticles and their relative merits and demerits.

(b) Method of biological synthesis of Zn and Ag nanoparticles – plant extract, bacteria and fungi.

Module 2: Applications of bionanotechnology (2 hrs)

Use of nanoparticles in agriculture, medicine and environment. Impact of NPs on germination and seedling emergence, parameters in various crops. Effect of NPs on gene expression. Translocation and accumulation of NPs in plant tissues and organs.

Practical (36 Hrs)

1. Production of amylase by solid state and submerged fermentation.
2. Preparation of the stock solutions of MS medium.
2. Preparation of MS medium from stock solutions.
3. Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium.
4. DNA isolation from coconut/onion/cauliflower and separation using agarose gel.
5.Blast search with Protein Sequence (*Magnolia latahensis*sequence)
6. Blast search with Nucleic Acid Sequence (Neanderthal man's Paleo DNA)
7. Phylogenetic tree creation with the help of CLUSTAL X, W or MUSCLE and tree drawing tools.
8. Creation of phylogentic trees for selected families ofEudicots
9. Molecular docking (using either free or commercialSoftware)

References

1. Susan R. Barnum (1998). *Biotechnology: an introduction*. Thomson Brooks/cole.
2. George Acquaah (2005). *Understanding biotechnology*. Pearson.
3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
4. S. B. Primrose, R. M. Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
5. Robert J Brooker (2009). *Genetics: Analysis & principles* (III Edn.). McGraw Hill.
6. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
7. Robert F Weaver (2002). *Molecular biology* (II Edn). McGraw Hill.
8. Smita Rastogi, Neelam Pathak (2010). *Genetic engineering*. Oxford.
9. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson.
10. David W Mount (2001). *Bioinformatics: Sequence and genome analysis*. CBS publishers & distributors.
11. Jeremy W Dale, Malcolm von Schantz (2002). *From genes to genomes*. John Wiley & Sons Ltd.
12. David P Clark (2010). *Molecular biology*. Elsevier.

13. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
14. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
15. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
16. Peter J Delver, Seamus J Martin, Dennis R Burton, Ivan M Roitt (2011). *Roitt's essential immunology* (XII Edn). Wiley Blackwell.
17. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X* . Jones and Bartlett Publishers.
18. Paul G Higgs, Teresa K Attwood (2005). *Bioinformatics and molecular evolution*. Blackwell publishing.
19. John L Ingraham, Catherine A Ingraham (2000). *Introduction to microbiology* (II Edn). Brooks/Cole.
20. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.
21. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*. Bios scientific publishers.
22. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
23. T A Brown (2002). *Genomes* (II Edn). Bios.
24. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.
25. Zhumur Ghosh, Bibekanand Mallik (2008). *Bioinformatics: principles and applications*. Oxford University press.
26. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
27. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn). Oxford University Press.
28. S S Bhojwani, M K Razdan (1996*). Plant tissue culture: Theory and Practice*. Elsevier.
29. Teresa K Attwood, David J Parry-Smith, Simiron Phukan (2007). *Introduction to Bioinformatics*. Pearson Education.
30. T A Brown (1995). *Gene cloning: an introduction* (III Edn). Stanley Thomas (Publishers) Ltd.
31. S B Primrose (1999). *Molecular biotechnology* (II Edn). Panima Publishing Corporation.
32. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn). Oxford University press.
33. Trever Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T. Palmer/ Harwood Publishing Limited.
34. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology and Biotechnology* (II Edn). Taylor & Francis.
35. Colin Ratledge, Bjorn Kristianson (2001). *Basic biotechnology*. Cambridge University press.
36. O L Gamborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamental methods*. Narosa Publishing House.
37. *In vitro cultivation of plant cells*. Biotechnology by open learning. Elsevier.
38. D E Evans, J O D Coleman, A Kearns (2003). *Plant Cell Culture*. BIOS Scientific Publishers.

39. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
40. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
41. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2012). *Introduction to genetic analysis*. W H Freeman and Company.
42. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of applied microbiology*. Cambridge University Press.
43. Edwin F George, Michael A Hall, Geert-Jan De Klerk (2008). *Plant Propagation by Tissue Culture: The Background* (Vol I). Springer.
44. L E Casida (2005). *Industrial Microbiology.* New Age International Limited.
45. Peter F Stanbury and Allan Whitaker (1999). *Principles of Fermentation technology.* Butterworth-Heinemann.
46. S C Prescott and Cecil Gordon Dunn (2004). *Industrial Microbiology.* CBS publishers and distributors.
47. A H Patel (2000). *Industrial Microbiology*. Macmillan Publishers.
48. Ashok Pandey (2001). *Solid state fermentation in biotechnology.* Asiatech publishers.
49. Rocha M and Ferreira P G (2018). Bioinformatics Algorithms (I Edn). Academic Press.
50. Momand J and McCurdy M (2017). Concepts in Bioinformatics and Genomics. Oxford University Press.
51. Jeremy R (2015). Bioinformatics: An Introduction. Springer Publishing Co.
52. Choudhuri S (2014). Bioinformatics for Beginners (I Edn). Academic Press

BY010303:ANGIOSPERM TAXONOMY, ECONOMIC BOTANYAND ETHNOBOTANY

(Theory - 72 Hrs;Practical - 63 Hrs; Credits: 4)

Module 1:Introduction (6 hrs)

Scope and significance of taxonomy. Major classification systems with emphasis on conceptual basis of classifications of (i) Linnaeus (ii) Bentham & Hooker (iii) Engler & Prantl (iv) Bessey (v) APG (brief synoptic account – current views).

Module 2:Units of classification and Phylogeny of Angiosperms(9hrs)

(a) Taxonomic hierarchy

(b) Concept of taxa: Concept of species: taxonomic, biological & phylogenic species. Concept of genus, family and infraspecific categories - subspecies, variety, forma.

(c) Phylogenetic terms: Premitive and advanced; Homology & Analogy; Parallelism and convergence; monophyly & polyphyly; phylogenetic tree(brief study).

(d) Numerical taxonomy and Cladistics – methodologies of study.

Module 3:Data sources of taxonomy (brief account): **(5hrs)**

(a) Concept of character

(b) Sources of taxonomic characters: Anatomy, cytology, phytochemistry, Molecular taxonomy, DNA barcoding.

Module 4:Methodology of Identification of plants(9 hrs)

(a) Usage of floras; Preperation of indented and bracketed keys

(b) Brief accounts on Flora of the British India, Flora of the Presidency of Madras, Hortus Malabaricus. Important Floras of Kerala

(c) Familiarization of Technical terms associated with the following: Habit, Habitat; Root, Stem, Leaf, Inflorescence; Bract & bracteoles; Flowers; Fruits and Seeds**.**

Module 5: **Tools of Taxonomy(3 hrs)**

Field study, Herbarium and Virtual herbarium, Important Botanical gardens; BSI; Botanical literature (Journals- print and online, Floras, Revisions,Monographs, Indices).

Module 6:Botanical Nomenclature (**4 hrs)**

(a) History of Botanical nomenclature and code

(b) Aims and principles of botanical nomenclature

(c) Study of major provisions of the code (ICN): Typification; Author citation; rule of priority; Effective and valid publication – as per the current code; Retention, rejection and choice of names.

Module 7:Study of angiosperm diversity (27 hrs)

Study of following families with reference to tropical flora, as per Bentham and Hooker's concept in detail with economic importance of members:

1.Ranunculaceae 2. Magnoliaceae 3. Annonaceae 4. Polygalaceae 5.Caryophyllaceae 6. Clusiaceae 7. Malvaceae8.Tiliaceae 9. Geraniaceae 10.Rutaceae 11. Vitaceae 12. Sapindaceae 13. Leguminosae 14. Myrtaceae 15.Melastomaceae16. Lythraceae 17. Cucurbitaceae 18. Aizoaceae 19. Apiaceae 20. Rubiaceae 21. Asteraceae 22.Campanulaceae 23. Myrsinaceae 24. Sapotaceae 25. Oleaceae 26. Apocynaceae 27. Asclepiadaceae 28. Boraginaceae 29. Convolvulaceae 30. Solanaceae 31.Scrophulariaceae 32. Acanthaceae 33. Verbenaceae 34. Lamiaceae 35. Polygonaceae 36. Aristolochiaceae 37. Lauraceae 38.Euphorbiaceae 39.Orchidaceae 40. Zingiberaceae 41. Liliaceae 42. Araceae 43. Cyperaceae 44.Poaceae.

Module 8:Economic Botany (6 hrs)

(a) Importance of economic botany. Important Plantation crops of Kerala and brief study on their various products - Rubber, Cardamom, Tea, Coffee, Coconut, Catechu.

(b) Major food plants: **Cereals**: Rice, wheat, maize, oats. **Millets**:Sorgum, Perl millet, Ragi, Italian millet. **Pulses**: Pigeon pea, Garden pea, Black gram, Green gram, Bengal gram. **Sugar**: Sugar cane.**Fruits**: Banana, Mango, Jack fruit, Apple, Pineapple, Orange, Lemon. **Vegetables**: All common vegetables used in traditional Keralakitchen. **Oil plants**: Coconut, Ground nut, Gingelly. **Spices**: Cardamom, Pepper,Ginger, Clove, Cinnamon, Coriander, Fennel, Fenugreek. **Fibre:** Coir, Jute, Cotton.

(c) **Gums and Resins**: White Damar, Gum Arabic, Asafoetida.

(d) **Medicinal plants**: Liquorice, Indian Sarsaparilla, Chitraka(*Plumbago*), Serpntine, Aswagandha, Asafoetida, Greater galanga,Turmeric, Mango ginger, Garlic, Ginger, Asoka tree, Vasaka, Indian Aloe, Holy Basil, Bel, Betel, Pepper, Belleric, Myrobalan, Chebulic myrobalan, Neem, Apple of peru(*Datura*).

Module 9: Ethnobotany (3 hours)

Importance, sources and methods; important tribal people of Kerala; plants used by them such as *Trichopus zeylanicus, Ochlandra travancorica, Dendrocalamus strictus, Gloriosa superba, Emilia sonchifolia, Andrographis paniculata*.

Practical (63 Hrs)

1. Workout a minimum of 2 members from each family with suitable sketches and description in technical terms of locally available plants. Record reasons assigned for Class, subclass, series/order, family and draw at least one species from each family in the record.

2. Identification of local flora using Flora of Presidency of Madras- J. S. Gamble.
3. Conduct study tour for not less than 5 days to study angiosperm diversity and collect plants from diverse habitats belonging to plant families specified above and also visit important botanical gardens and institutions of taxonomic research and submit a report.
4. Preperation of 25 herbarium specimens from the plant families of study and submit.
5. Study of preperation of dendrogram using a suitable software (of a family or Genus of study).
6. Workout nomenclatural problems regarding priority and author citations.
7. Familiarization of morphological terms form live specimens; specimens of economic botany from families of study.

References

1. Cole, A.J. (1969). *Numerical Taxonomy*. Academic Press.
2. Cronquist A.(1981). *An Integrated System of flowering plants*. Columbia University Press.
3. Davis, P.H &, V H Heywood,(1991).*Principles of Angiosperm Taxonomy*. Today and Tomorrow Publications. N.Delhi.
4. Davis, P.H., Heywood,VM(1973). *Principles of Angiosperm Taxonomy*.Robert E K publ.
5. Gurcharan Singh(2004). *Plant Systematics: Theory & Practice*. Oxford IBH Publ.
6. Harrison, H J.(1971). *New concepts in Flowering plant Taxonomy*. Heiman Educ.books.
7. Henry A.N. & Chandrabose M. (1980). *An aid to the International code of Botanical Nomenclature.*
8. Heywood, V.H& D. M Moore (Eds) (1984). *Current Concept in Plant Taxonomy*.
9. Hill, A. F. (1937). *Economic Botany*. Tata McGraw Hill Publ. Co. Ltd.
10. *International Code of Nomenclature for Algae, Fungi and Plants*(Shenzhen Code). 2018.
11. Jain,S.K. (1995). *A manual of Ethnobotany.* ScientificPublishers; Jodhpur.
12. Jeffrey,C. (1982) *An Introduction to Principles of Plant Taxonomy*.
13. Lawrence GHM (1951). *Taxonomy of Vascular plants*. Oxford & IBH.
14. Maheswari, J. K. (2000). *Ethnobotany and medicinal Plants of Indian subcontinent*. Scientific Publishers. Jodhpur.
15. NaikV. N.(1984). *Taxonomy of Angiosperms*. Tata McGraw hill Publ. Co. Ltd., N. Delhi.
16. Pandey, B.P.(1978). *Economic Botany*. S. Chand & Co. New Delhi.
17. Radford A E (1986). *Fundamentals of Plant systematics*. Harper & Row Publ.
18. Sasidharan, N.(2004). Biodiversity documentation for Kerala. Pt. 6. Flowering Plants. KFRI, Peechi, Kerala
19. Sivarajan, V.V.(1991).*Introduction to Principles of Plant Taxonomy*. Oxford I B H. Delhi
20. Stuessy T F (2002). *Plant Taxonomy. The systematic Evolution of Comparative data*. Bishen Singh Mahendra Pal Singh. Dehra Dun.
21. Takhtajan, A.L.(1997). *Diversity and Classification of Flowering plants*. Columbia Univ. press
22. Taylor D.V. & L.J. Hickey (1997). *Flowering plants. Origin, evolution and Phylogeny*. CBS publishers and Distributors.

BY010304: ENVIRONMENTAL SCIENCE

(Theory 54 Hrs; Practical 27 Hrs; Credits 3)

Module 1: Introduction to Ecological Science (2 hrs)

Definition, history and scope of ecology, Interdisciplinary nature of environmental sciences.

Module 2: Autecological concepts - Population Ecology (5 hrs)

(a) Characteristics of populations - size and density, dispersion, age structure, natality and mortality.

(b) Population growth - factors affecting population growth, environmental resistance, biotic potential, carrying capacity, positive and negative interaction, migration, subsistence density. Ecological consequence of overpopulations.

(c) Genecology - ecological amplitude, ecads, ecotypes, ecospecies, coenospecies,

Module 3: Synecological concepts - Community ecology (5 hrs)

(a) Ecological processes of community formation, ecotone, edge effect. Classification of communities - criteria of classification, dynamic system of classification by Clement.

(b) Special plant communities - quantitative, qualitative and synthetic characteristics of plant communities, coefficient of communities; Sorenson's Index of similarity.

(c) Dynamic community characteristics - cyclic replacement changes and non-cyclic replacement changes.

Module 4: Dynamic Ecology - Ecological succession (3 hrs)

(a) The concept, definition and reasons of succession. Classification of succession: Changes - autogenic and allogenic, primary and secondary, autotrophic and heterotrophic.

(b) Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities.

Module 5: Biosphere and Ecosystem (7 hrs)

(a) Significance of habitat, biodiversity, ecological niche, trophic level, primary and secondary productivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles.

(b) Comparative study of the major tropical ecosystems: Tropical rain forests, Wetlands and tropical coastal ecosystems. Special emphasis to tropical coastal ecosystems: Conservation and management of tropical coastal ecosystems: The values of coastal ecosystems, issues of coastal ecosystems in the tropics, goals for conservation and management of tropical ecosystems: Providing for resilience, maintain/restore connectivity, protect water quality, conservation and recovery of Species-at-Risk, understanding the socio-economic context.

Module 6: Phytogeography (5 hrs)

(a) Definition, principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution.

(b) Climate, vegetation and botanical zones of India.

(c) Remote sensing: Definition and data acquisition techniques. Application of remote sensing, geospatial variability and geotagging.

Module 7: Environmental pollution (10 hrs)

(a) Definition and classification.

(b) Water pollution: Water quality parameters and standards, different types of pollutants and their consequences. Types of water pollution, prevention and control - water shed management, waste water treatment. Waste water treatment with aquatic macrophytes.

(c) Air pollution: Air quality standards and index, ambient air monitoring using high volume air sampler, types and sources of air pollutants, air pollution and human health hazards, control of air pollution.

(d) Noise pollution.

(e) Radioactive and thermal pollution: Causes and hazardous effects, effective management.

Module 8: Environmental biotechnology and solid waste management (4 hrs)

Concept of waste, types and sources of solid wastes including e-waste. Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. Use of bioreactors in waste management.

Module 9: Global environmental problems and climate change (4 hrs)

(a) Global warming, green house gases, acid rain, ozone depletion. Holistic relationship between air water and land pollution.

(b) Factors responsible for climate change, *El-Nino* and *La Nina* phenomenon and its consequences.

(c) Effect of climate change on biogeography.

(d) Environmental laws, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in India, ISO-14000.

(e) Disaster management; preparedness and planning

Module 10: Biodiversity and its conservation (9 hours)

(a) Biodiversity- definition, the number of known plants in the world (upto groups), current biodiversity loss - concept of endemism, rare, endangered and threatened species (RET), key stone species, IUCN account of biodiversity, red data book and hot spots, reasons to stop extinction, methods to save species.

(b) Principles of conservation - *ex-situ* and *in-situ* conservation techniques. Biodiversity conservation: Species diversity, community diversity, ecosystem diversity. Role of biotechnology in conservation of species.

(c) The natural longevity of species, rain forests as centres of diversity, ecological restoration

(d) Ecotourism - positive and negative impacts.

Practical (27 hrs)

1. Analysis of water quality for; (a) Dissolved CO_2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate (f) Total alkalinity.

2. Quantitative estimation of dissolved silicate, dissolved sulphate, nitrite and total alkalinity.

2. Physico-chemical analysis of soil: (a) Total water soluble mineral ions (b) estimation of soil organic carbon (Walkey and Black method).

3. Quantitative and qualitative community analysis. Carry out a project on species structure and the frequency, abundance, density of different species and similarity index of different communities in a natural system. Students must be able to explain the structure of vegetation from the given data on the above mentioned characteristics.

4. Phytoplankton counting using Sedgwick Rafter counter.

5. Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community) and submit a report.

6. Students should be aware of the common environmental problems, their consequences and possible solutions.

References

1. Ahmedullah M, Nayar M P (1987). *Endemic plants of India*.
2. APHA, Awwa, Wep. *Standard methods for the examination of water and waste water*.
3. Barbour M D, et. al., (1980). *Terrestrial plant ecology.* The Benjamin-Cammings Pub. Com.
4. Benton A H, Werner W E (1976). *Field biology and Ecology*. Tata McGraw Hill.
5. Christenhusz M J M, Byng J W (2016). *The number of known plants species in the world and its annual increase*. Phytotaxa, 261 (3): 201-217. http://dx.doi.org/10.11646/phytotaxa.261.3.1.
6. Clarke G L (1954). *Elements of Ecology.* John Wiley Pub.
7. Dash M C (1993). *Fundamentals of Ecology*. Tata McGraw Hill.
8. *Ecological Guidelines for tropical costal developments*. UNESCO.
9. Eldon D, Enger, Bradley, Smith F (1995). *Environmental Science*. W C Brown publications.
10. Emery W, Camps A (2017). *Introduction to satellite remote sensing*. Elsevier.
11. Furley P A et. al., (1983). *Geography of the biosphere: An introduction to the nature, distribution and evolution of the world life zones*. Butterworths.

12. IUCN (2000). *The IUCN red list category*. IUCN England.
13. IUCN (2007). *The 2000 IUCN red list of threatened species*. IUCN. England.
14. Jain S K, Sastry A R K (1984). *The Indian plant red data book*. BSI, Calcutta.
15. Jones H G, Vaugham R A. *Remote sensing of vegetation*. Oxford university press.
16. Jorgensson S E. (2009). *Ecosystem Ecology,* Elsevier.
17. Kormondy E J (Ed) (1965). *Reading in ecology*. Prentice Hall.
18. Kormondy E J (Ed) (1999). *Concept of ecology*. Prentice Hall.
19. Kumar H D (1977). *Modern concept of ecology*. Vikas Publication.
20. Michael P (1984). *Ecological methods of field and laboratory investigations*. Tata McGraw Hill.
21. Misra K C. *Manual of plant ecology*. Oxford and IBH Pub. Com. P. Ltd.
22. Nagelkerker, I. (2009*). Ecological connectivity among tropical coastal ecosystems*, Springer.
23. Odum E P (III Edn) (1991). *Fundamentals of ecology*. Saunders and Com.
24. Odum E P, Barrett G W (2005). *Fundamentals of Ecology*- 5th Edition. Brooks/Cole Publishing Co.
25. Osborne P L (2012). *Tropical Ecosystems and Ecological Concepts*, 2nd edition. Cambridge University Press
26. Pearcy R W et. al., (1989). *Plant physiological Ecology: Field methods and instrumentation*. Chapman and Hall.
27. Ramade F (1981). *Ecology of natural resources*. John Wiley and sons.
28. Schowengerdt R (2012). *Remote sensing* 2nd edition, Academic Press.
29. Sharma P D (1999). *Ecology and Environment*. Rastogy Pub.
30. Simons I G (1981). *Ecology of natural resources*. Edwin-Arnold Ltd.
31. Smith T M and Smith R L. (2012). *Elements of ecology*, 8th edition, Benjamin Cummins.
32. Trivedi R K. *Practical methods in Ecology and Environmental sciences*. Envt. pub.
33. Trivedi R. *International encyclopedia of ecology and environment* (Vol.1). IIEE, New Delhi.
34. Varma P S, Agarwal V K. *Principles of Ecology*. S Chand and Co.
35. Walter (1987). *Vegetation of the earth*. Springer Verlag.
36. Wilson E O (1988). *Biodiversity.* The national academic press.
37. Wilson E O (1999). *The diversity of life.* W.W. Norton and Company.

MODEL QUESTION PAPERS – THEORY

M Sc Botany Degree (CSS) Examination

III Semester

Faculty of Science

BY010301: RESEARCH METHODOLOGY, MICROTECHNIQUE,BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Describe the structure of scientific library.
2. Describe the principle and technic of fixing. Write the composition of FAA.
3. Give brief account of different type of journals.
4. Describe Primary and Secondary data.
5. Describe quantitative and qualitative data.
6. Write the principle and use of Phase contrast microscope.
7. Why is a statistical test necessary to determine the exceptability of an observed set of data?
8. Write the preparation of hematoxylin.
9. What are the use of colorimeter?
10. List out different type of microtomes used in microtechnique.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write an essary on literature survey and its importance in research.
12. What are a different stages of research?
13. Write note on permanent whole mount preparation.
14. What are histochemical stain? Write its significance.
15. Describe the principles of electron microscopy.
16. How chi-square test is used for the detection of linkages?
17. Describe the basic principles and applications of ELISA.
18. Write a short essay on electrophoresis.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Prepare a sample project proposal on environment problem for submission to UGC.
20. Describe various steps in making permanent serial sections.
21. Describe experimental designing used for different types of study.
22. Write an essay on different types of electron microscope.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
III Semester
Faculty of Science

BY010303: ANGIOSPERM TAXONOMY, ECONOMIC BOTANYAND ETHNOBOTANY

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Describe the primitive characters Magnoliaceae.
2. Explain the pliesiomorphic and apomorphic characters.
3. Write an account on androecium of Orchidaceae.
4. Write the binomials and families of the following:
   (a) Tea (b) Chinese Potato (c) Rose wood (d) Cane
5. With the suitable example describe the medicinal importants of Apocymaceae.
6. Give the family name and economic products of the following plants:
   (a) *Mentha arvelsis* (b) *Lagenaria vulgaris* (c) *Cymbopogon citrates* (d) *Foeniculum vulgare.*
7. What is herbariam? How herbariam is labeled?
8. What is Ethnobotany?
9. Give any two plant products used by tribals for stomac ache.
10. What is BSI? Write its functions.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Critically evaluate the Engler's system of classification.
12. Compare the families of Verbenaceae and Lamiaceae.
13. Explained different type of keys used for plant identification.
14. Write the economic importance of family Cucurbitaceae.
15. Explain the floral characters of Euphorbiaceae.
16. Comment on the systematic position and effenity of the following genera.
    (a) *Nyctanthes*(b) *Coleus* (c) *Luffa*
17. Describe the advanced floral characters in the families of disciflorae.
18. Comment on the economic importance of the following:
    (a) *Saccharum officinarum* (b) *Dalbergia sissoo* (c) *Adhatoda vasica* (d) *Cinnamomum camphora*

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Critically evaluate the system of classification of angiosperm by Hutchinsom and compare it with B&H classification.
20. Describe the floral features of Umbelliferae and Guttiferae.
21. Compare and vegetatitve and floral features of the families of Bicarpellatae and write note on its evolutionary trends.
22. Critically evaluate the phonetic and cladistic approaches in plant systematic.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
III Semester
Faculty of Science
BY010304: BIOTECHNOLOGY, BIOINFORMATICS AND BIONANOTECHNOLOGY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Differentiate between stirred tank and airlift bioreactors.
2. Define the following;
(a) Totipotency (b) Synseeds (c) Haploids (d) Stem cells
3. What is androgenesis?
4. What are the causes of somaclonal variation?
5. Name four industrial chemicals produced by using microbial activities. Write the names of the microorganisms involved in each.
6. Describe the importance of using tissue culture in producing secondary metabolites.
7. What is enzyme engineering? What are the applications of it?
8. Briefly describe bioaugmentation.
9. How are triploids produced?
10. How do we produce stem cells?

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write an account on the procedure and applications of hairy root culture.
12. Giving suitable examples, discuss downstream processing.
13. What are cybrids? How are they produced? Discuss the use of cybrids in crop improvement programmes.
14. Citing suitable examples, discuss the importance of GMOs in bioremediation
15. Describe the procedure of plant protoplast isolation and purification.
16. Briefly describe the prospects and future of stem cell research.
17. What is germplasm? Describe the methods of germplasm conservation. Add a note on the importance of tissue culture as a method of germplasm conservation
18. Write an account on the methods and applications of cell immobilization.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe the procedure and applications of;
(a) Cryopreservation (b) Protoplast culture (c) Microspore culture (d) Cellulase production

20. What is enzyme immobilization? Describe the steps involved and the potential applications. Add a note on enzyme engineering.
21. Write an essay on bioremediation.
22. Describe the various tissue culture techniques used to produce ploidy variants in plants.

(2 x 5 = 10)

M Sc Botany Degree (C.S.S) Examination

III Semester

Faculty of Science

Course Code- BY010304: Environmental Science

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Define the scope of ecology
2. What is biotic potential?
3. Describe ecads and ecotypes
4. Define consociation and formation
5. What is meant by resilience of communities?
6. Define primary production
7. Describe discontinuous distribution with suitable example
8. What is smog?
9. Define phytoremediation
10. Define key stone species

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. What is ecotone and edge effect
12. What are wetlands, why they are known as *biological supermarkets* and *kidneys of landscapes*
13. Describe the community classification by Clement
14. Describe geospatial variability and geotagging
15. Mention the factors affecting plant distribution
16. Comment on disaster management
17. Mention the causes and effects of radioactive pollution
18. Distinguish between *El-Nino* and *La Nina* phenomenon

(**6 x 2 = 12**)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Global warming and its impacts
20. Explain remote sensing and its applications
21. Illustrate tropical coastal ecosystems
22. Elaborate biodiversity and principles of conservation

(**2 x 5 = 10)**

MODEL QUESTION PAPERS - PRACTICAL
BY010305: RESEARCH METHODOLOGY, MICROTECHNIQUE, BIOSTATISTICS, BIOPHYSICS AND BIOTECHNOLOGY

Time: 4 hours **Weightage:30**

1.Viva voce based on the project proposal submitted by the student.
(Total weight 2: project proposal – 1; Viva – 1)
2. Prepare a double stained micropreparation of material A and mount it as a permanent slide.
(Total weight 4: Sectioning and staining – 3; Mounting – 1)
3. Prepare serial sections of B and mount on a glass slide
(Total weight 3: Microtome sectioning – 2; Mounting – 1)
4. Permanent slides
(Weight 4)
5. Workout problemsC and D.
(Weight 2 x 2 = 4)
6. Determine the size of the given filament/pollen/spore D using micrometer
(Total weight 2: Calibration – 0.5; Measurement, calculation and result – 1.5)
7.Prepare _____ ml liquid medium (MS) containing _____ µM Cytokinin and _____ µM Auxin. Write down the protocol for the same with calculations. Adjust the pH of the medium as specified.
(Total weight 4: Calculation and protocol – 2; Preparation - 2)
8. Draw a phylogenetic tree using the gene sequence data file with the help of CLUSTAL X/W or MUSCLE and tree drawing tool
(Total Weight 3: MSA - 1.5; Phylogenetic tree - 1.5)

OR

Blast search with the given protein sequence (e.g. *Magnolia latahensis* sequence)
(Total Weight 3: BLAST Search - 2.5; Downloading first 10 results - 0.5)
9. Practical record.
(Weight 4)

Key to the questions:
1. Submit a project proposal by each student; conduct a Viva voce based on it.
2. A – Fresh plant material suitable for taking hand sections
3. B – Embedded paraffin blocks, mounting the ribbon in a minimum of two rows.
4. Permanent slides prepared by the student as specified in the syllabus and certified by the head of the department
5. C – Problem from Probability/Chi-square test/t-test.
6. Give necessary samples
7. Supply stock solutions necessary to prepare MS medium.
8. Centre should provideprocessedtext file containing phylogenetically related gene sequences in FASTA format. Tools for MSA such as CLUSTAL and MUSCLE create output files. Such output files are the source files for the creation of Phylogenetic trees using tools like NJ Plot or Dendroscope

OR

Download protein sequences like Magnolia latahensisrbcL gene from genbank and save it in each desktop.
9. Awarding 'A grade' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly.This also includes field study report(s)/Lab visit report(s), if any.

BY010306: ANGIOSPERM TAXONOMY, ECONOMIC BOTANY AND ENVIRONMENTAL SCIENCE

Time: 4 hours **Weightage:30**

1. Identify the families of the given specimens A and B.
(Total weight 2.5: Identification up to series with reasons – 0.5; Identification up to cohort with reasons – 0.5; Identification of the family with reasons – 1.5; 2 x 2.5 = 5)
2. Identify the given material C up to genus.
(Total weight 3: Identification up to family with reasons – 1; Identification of genus with author citation – 1; Genus key – 1)
3. Identify the given material D up to species.
(Total weight 4: Identification up to family – 0.5; Identification of genus with author citation – 1; Genus key – 0.5; Identification of species with author citation – 1; Species key – 1)
4. Describe the given material E in technical terms. Draw L.S of the flower, floral diagram and write the floral formula.
(Total weight 3: Vegetative characters – 0.5; Floral characters – 0.5; LS – 1; Floral diagram – 0.5; Floral formula – 0.5)
5. Prepare an artificial key to identify the 4 specimens given, F, G, H, I.
(Weight 2)
6. Write the Economic/ethnobotanicalimportance of the materials J, K, L and M.
(Weight 0.5: 0.5 x 4 = 2)
7. Herbarium and field book.
(Weight 2)
8. Identification of herbarium specimens N and O.
(Total weight 2: genus 0.5; species - 0.5; 1 x 2 = 2)
9. Quantify nitrite /silicate/sulphate in the given sample Pusing Spectrophotometer/ Colorimeter.
(Total weight 3: Working – 1; Procedure – 1; Result and Comments – 1)
10. Practical record
(Weight = 4)

Key to the questions:

1. A, B – Plant materials for family identification
2. C – Material for genus identification
3. D – Material for species identification
4. E - Give a plant twig complete with vegetative and floral features.
5. F, G, H, I – Supply appropriate specimens to prepare a key.
6. Raw or finished products of economically/ethnobotanically important plants
7. Herbarium (25 nos) and field book certified by the head of the department and submitted by the student.
8. N, O - Write the binomials of the two herbarium specimens selected randomly by the examiner.
9. P - Supply suitable water samples
10. Awarding 'A grade' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly.This also includes field study report(s)/Lab visit report(s), if any.

SEMESTER IV

FOURTH SEMESTER COURSES

PROGRAMME ELECTIVE - BIOTECHNOLOGY				
Course code	Title	Teaching Hrs.		Credits
		Theory	Practical	
BY800401	Plant tissue culture and Microbial biotechnology	90	72	4
BY800402	Genetic engineering, Genome editing and Immunology	90	72	4
BY800403	Genomics, Transcriptomics, Proteomics and Bioinformatics	90	72	4
BY800404	Plant tissue culture and microbial biotechnology - Practical			2
BY800405	Genetic engineering, Genome editing and Immunology & Genomics, Transcriptomics, Proteomics and B-Practical			2
	Project work			4
	Viva-voce			3
PROGRAMME ELECTIVE - MICROBIOLOGY				
BY810401	Food, agriculture and enviornmental microbiology	90	72	4
BY810402	Clinical microbiology	90	72	4
BY810403	Food industrial microbiology	90	72	4
BY810404	Food, agriculture and enviornmental microbiology - Practical			2
BY810405	Clinical microbiology and Food industrial microbiology - Practical			2
	Project work			4
	Viva-voce			3
PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE				
BY820401	Basic concepts in environmental studies	90	72	4
BY820402	Natural resources and their management	90	72	4
BY820403	Environmental monitoring and management	90	72	4
BY820404	Basic concepts in environmental studies - Practical			2
BY820405	Natural resources and their management & Environmental monitoring and management - Practial			2
	Project work			4
	Viva-voce			3

Total Credits: 23
Total Hours: 450

PROGRAMME ELECTIVE - BIOTECHNOLOGY
BY800401. PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY
(Theory 90 hrs; Practical 72 hrs; Credits 4)

Module 1: Tissue culture regeneration of plants (10 hrs)

(a) Adventitious shoot regeneration: Direct and indirect regeneration; factors influencing adventitious regeneration.

(b) Somatic embryogenesis: Direct and indirect, initiation of embryogenic cultures and regeneration of plants; factors regulating somatic embryogenesis. Synthetic seed production - protocol, types of synthetic seeds. Applications and limitations of synthetic seeds.

Module 2: Somaclonal variation (8 hrs)

Origin of somaclonal variation. Reasons for somaclonal variation – molecular basis. Applications of somaclonal variation.

Module 3: Embryo and meristem culture (3 hrs)

Methodology and applications.

Module 4: Protoplast culture (8 hrs)

(a) Isolation, purification and culture of protoplasts. Regeneration of plants from protoplasts. Significance of protoplast culture.

(b) Protoplast fusion (somatic hybridization) – chemical, mechanical, electrofusion. Isolation and selection of heterokaryons, regeneration and analysis of somatic hybrids; Cybrids. Applications of protoplast culture and somatic hybridization.

Module 5: Production of ploidy variants (12 hrs)

(a) Haploids: In vitro androgenesis – protocol for anther and microspore culture, advantages, applications. **Gynogenesis -** Developmental stage at inoculation, *in vitro* maturation of embryo sacs, origin of embryos, triggering factors – pretreatment, medium. Uses and limitations of haploid plants.

(c) Triploids: importance of triploid plants, conventional production of triploid plants, endosperm culture - advantages and limitations.

Module 6: In vitro germplasm conservation (6 hrs)

Importance of *in vitro* conservation. Short and medium term storage of germplasm, Cryopreservation technique – importance and methodology of cryopreservation. DNA banking for germplasm conservation.

Module 7: Production of secondary metabolites (6 hrs)

Culture conditions for producing secondary metabolites, selection of high yielding lines, elicitation. Hairy root culture – advantages of using hairy root culture, establishment of hairy root culture and production of secondary metabolites. Biotransformation.

Module 8: Cell and enzyme technology (5 hrs)

(a) Cell immobilization: Methods, advantages and applications.

(b) Enzyme immobilization: Methods and applications. Enzymes as biosensors. Enzyme engineering,

Module 9: Microbial technology (16 hrs)

(a) Screening of microbes for metabolite production - selection of media, strain improvement. Bioreactors – airlift, stirred tank, bubble column, rotary drum. Fermentation process - batch, fed batch, continuous fermentation. Process control during fermentation - pH, aeration, agitation, temperature, foam control. Downstream processing.

(b) Large scale production of antibiotics - penicillin, streptomycin; industrial chemicals - ethanol, acetone, citric acid; SCP – *Spirulina* and *Chlorella*; Biofertilizers – *Azotobacter* and *Rhizobium*; Bioinsecticides – *B. thuringeansis*, NPV. Commercial production of enzymes and their uses - amylase, cellulase, polygalacturonase.

Module 10: Tissue engineering and Stem cell technology (6 hrs)

Regenerative medicine, methods and applications of tissue engineering. Stem cells – embryonic stem cell and adult stem cells – production and applications.

Module 11: Bioremediation (10 hrs)

Importance and advantages of bioremediation, bioleaching, xenobiotics, organisms used for bioremediation. Cleaning strategies for water and soil - *in situ* and *ex situ* technologies. Bioremediation of radioactive wastes. Use of GMOs in bioremediation.

Practical (72 hrs)

1.Isolation of explants, establishment, subculture and maintenance of callus.
2. In vitro morphogenetic studies in any one plant system
3. Study of the morphology of callus cells – callus smear prelaration, histological aspects, microtomy.
4. Isolation and fusion of plant protoplasts.
5. Preparation of synthetic seeds.
6. Preparation of selective medium for drought or salinity resistance. Preparation of MS medium from stock solutions containing auxin and cytokinin, NaCl or PEG, and inoculation.
7. Cell immobilization.
8. Application of immobilized yeast cells for ethanol production.
9. Isolation of microbes producing Organic acids/Enzymes.
10. Find out the uninucleate stage of pollen for anther culture.
11. Dissect out an embryo from any seed and culture it on a suitable solid medium.
12. Cell plating technique.

References

1. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*. Bios scientific publishers.
2. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn). Oxford University Press.
3. S S Bhojwani, M K Razdan (1996). *Plant tissue culture: Theory and Practice*. Elsevier.
4. Susan R. Barnum (1998). *Biotechnology an introduction*. Thomson Brooks/cole.
5. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn). Oxford university press.
6. Trever Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T Palmer/Harwood Publishing Limited.
7. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology and Biotechnology* (II Edn). Taylor & Francis.
8. O L Gamborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamental methods*. Narosa Publishinh House.
9. *In vitro cultivation of plant cells*. Biotechnology by open learning. Elsevier.
10. John L Ingraham, Catherine A Ingraham (2000). *Introduction to microbiology* (II Edn). Brooks/Cole
11. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.

12. Colin Ratledge, Bjorn Kristianson (2001). *Basic biotechnology*. Cambridge University press.
13. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson.
14. D E Evans, J O D Coleman, A Kearns (2003). *Plant Cell Culture*. BIOS Scientific Publishers.
15. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
16. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of applied microbiology*. Cambridge University Press.
17. Anne Kathrine Hvoslef-Fide, Walter Preil (Eds) (2005). *Liquid Culture Systems for in vitro Plant Propagation*. Springer.
18. Edwin F. George, Michael A. Hall, Geert-Jan De Klerk (2008). *Plant Propagation by Tissue Culture (Vol I): The Background*. Springer.
19. Michael R. Davey, Paul Anthony (2010). *Plant Cell Culture: Essential Methods*. Wiley-Blackwell A John Wiley & Sons, Ltd.
20. Trevor A. Thorpe and Edward C. Yeung (Eds) (2011). *Plant Embryo Culture: Methods and Protocols*. Springer, Heidelberg.
21. Barbara M. Reed (2008). *Plant Cryopreservation: A Practical Guide*. Springer, Heidelberg.
22. Erica E. Benson (1999). *Plant Conservation Biotechnology*. Taylor and Francis.
23. Pritchard H W (2004). *Modern methods in orchid conservation: The role of Physiology, Ecology and Management*. Cambridge University Press.
24. Wen-Huei Chen, Hong-Hwa Che (2007). *Orchid Biotechnology*. World Scientific Publishing Co. Pvt. Ltd.
25. Joseph Arditti (2008). *Micropropagation of Orchids* (Vol. I). Blackwell publishing.
26. Alisher Touraev, Brian P. Forster, S. Mohan Jain (Eds) (2009). *Advances in Haploid Production in Higher Plants*. Springer, Heidelberg.
27. S Mohan Jain, H. Häggman (Eds) (2007). *Protocols for Micropropagation of Woody Trees and Fruits*. Springer, Heidelberg.
28. L E Casida.(2005) *Industrial Microbiology.* New Age international limited.
29. Peter F Stanbury, Allan Whitaker (1999). *Principles of Fermentation technology.* Butterworth-Heinemann.
30. S C Prescott, Cecil Gordon Dunn (2004). *Industrial Microbiology.* CBS publishers and distributors.
31. A H Patel (2000). *Industrial Microbiology*. Macmillan Publishers.
32. Ashok Pandey (2001). *Solid state fermentation in biotechnology.* Asiatech publishers.
33. Pauline M. Doran (1995). *Bioprocess Engineering Principles*. Academic Press Ltd.
34. M L Srivasthava (2007). *Fermentation technology*. Alpha Science Intl Ltd.
35. Gary Walsh (2002). *Proteins: .Biochemistry and Biotechnology*. John Wiley and Sons.
36. Ronald M Atlas, Jim Philip (2005). *Applied Microbial solutions for real-world environment clean up*. Amer Society for Microbiology.
37. Martin Alexander (1999). *Biodegradation and Bioremediation*. Academic Press.
38. Dennis Thomas, Rakhi chaturvedi (2008). *Endosperm culture: A novel method for triploid plant production*. Plant cell and organ culture, Springer science.

PROGRAMME ELECTIVE - BIOTECHNOLOGY
BY800402: GENETIC ENGINEERING, GENOME EDITING AND IMMUNOLOGY
(Theory 90 hrs; Practical 54 hrs; Credits 4)

Module 1: Important tools and techniques in gene cloning (18 hrs)

(a) DNA cutting and modifying enzymes: restriction endonucleases – types, mode of action; alkaline phosphatase, polynucleotide kinase, S1 nuclease, exonucleases, Ligases.

(b) In vitro DNA ligation strategies: Joining with ligases – adaptors, linkers and homopolymer tailing; topoisomerases, and site-specific recombinase

(c) Vectors: plasmid vectors, phage vectors and artificial chromosomes – BAC, YAC, PAC, HAC – important features, construction and applications of each.

(d) Cloning strategies: Genomic libraries, preparation of DNA fragments for cloning. Bacterial transformation, *in vitro* phage packaging and transfection.

(e) Selection and screening of recombinants: insertional inactivation, complementation of defined mutation, microarray techniques, immunological screening for expressed genes. Reporter systems – *Lac Z* system, GFP.

Module 3: Gene library (10 hrs)

(a) Genomic and cDNA library. Procedure for the construction of a genomic library using phage λ system. Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing, immunological screening. Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping.

Module 4: Advanced transgenic technology (6 hrs)

Inducible expression systems – trtracycline expression system; site-specific recombination for *in vivo* gene manipulation, gene targeting, gene silencing using antisense RNA and RNAi. RNAi therapy.

Module 5: Applications of rDNA technology (10 hrs)

(a) Uses of GM microbes: Bacteria and yeast– production of useful proteins, basic genetic research. Applications of GM animals: In basic research, producing novel proteins; disease studies, prevention and cure diseases.

(b) Uses of transgenic plants: Herbicide, insect and disease resistance, stress resistance. Genetic engineering for increasing nutritional and other novel qualities in plants, pharming.

Module 6: Genome editing (12 hrs)

(a) Process of genome editing: basic principle and steps involved in genome editing.

(b) Genome editing methods: Meganucleases, ZFN, TALEN, CRISPR/Cas9.

(c) Applications of genome editing: tool to study gene function, in genetic engineering, in gene therapy.

Module 7: Gene therapy (8 hrs)

Approaches to gene therapy- somatic cell and germline therapy, vectors used in gene therapy. *In vivo* and *ex vivo* therapy. Gene augmentation therapy. Problems and fears associated with gene therapy.

Module 8: Protein engineering (5 hrs)

Approaches to protein engineering - protein modification by site-directed mutagenesis, combinatorial methods. Applications of protein engineering.

Module 9: Biosensors (6 hrs)

Design and operation, types. Applications - medical, food and agriculture, industrial, pollution monitoring. GMOs as biosensors.

Module 10: Immunology (14 hrs)

(a) Innate and acquired immunity. Cells and molecules involved in innate and acquired immunity, humoral and cellular immunity, Antigens, Epitopes. Structure, function and types of antibody molecules.

(a) Generation of antibody diversity. Antigen-antibody interactions. Antigen processing and presentation. Activation and differentiation of B cells – formation, role. T cells – types, roles, T cell receptors. Primary and secondary immune modulation, complement system, pattern recognition receptors – toll-like receptors. MHC molecules. Cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, congenital and acquired immunodeficiencies.

(b) Production and uses of monoclonal antibodies, antibody engineering.

(c) Vaccines: Basic strategies, inactivated and live attenuated pathogens, subunit vaccines, recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines. Modern approaches to vaccine development - edible vaccines.

Practical (54 hrs)

1. Identification of chemicals/reagents, tools, techniques, and procedures used in genetic engineering.
2. Work out problems based on restriction digestion of DNA, gel separation pattern etc.
3. Isolation of plant genomic DNA and its quantification.
4. Isolation of plasmids and its purification, by minipreparation and midipreparation.
5. Isolation of bacterial genomic DNA and its quantification by using UV spectrophotometer.
6. Separation of DNA by agarose gel electrophoresis.
7. Extraction and quantification of protein by Bradford method.
8. Separation of proteins by PAGE.
9. Conduct PCR.

References

1. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
2. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
3. Robert J Brooker (2009). *Genetics: Analysis & principles* (III Edn). McGraw Hill.
4. T A Brown (2002). *Genomes* (II Edn). Bios.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
6. Abul K Abbas, Andrew H Lichtmay, Shiv Pillai (2007). *Cellular and molecular immunology* (IV Edn). Elsevier.
7. Charles A Janeway Jr., Paul Travers, Mark Walport, Mark J Schiomchik (2007). *Immunobiology*. Garland science, Churchill Livingstone.
8. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.
9. Smita Rastogi, Neelam Pathak (2010). *Genetic engineering*. Oxford.

10. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology: Principles and applications of recombinant DNA*. ASM press.
11. S B Primrose, R M Twyman, R W Old (2001). *Principles of gene manipulation* (VI Edn). Blackwell Science.
12. Jeremy W Dale, Malcolm von Schantz (2002). *From genes to genomes*. John Wiley & Sons Ltd.
13. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
14. P Nagarajan, N Senthilkumar (2002). *Molecular biology: Principles and methods*. Sree Narmatha printers, Coimbatore.
15. Joseph Sambrook, David W Russell (2001). *Molecular cloning: A laboratory manual*. Cold spring harbor laboratory press.
16. David P Clark (2010). *Molecular biology*. Elsevier.
17. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
18. Desmond S T Nicholl (2010). *An introduction to genetic engineering* (III Edn). Cambridge.
19. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
20. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
21. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
22. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.
23. Benjamin Lewin (2006) *Genes IX*. Jones and Bartlett.
24. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.
25. William J Thieman, Michael A Palladino (2009*). Introduction to biotechnology* (II Edn). Pearson.
26. Carl Branden, John Tooze (1999). *Introduction to protein structure* (II Edn). Garland Publishing.
27. *Science*August 3, 2007:Vol. 317 no. 5838 pp.
28. *Science*, May 20, 2010.
29. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology and Biotechnology* (II Edn). Taylor & Francis.
30. T A Brown (1995). *Gene cloning: An introduction* (III Edn). Stanley Thomas (Publishers) Ltd.
31. S B Primrose (1999). *Molecular biotechnology* (II Edn). Panima Publishing Corporation.
32. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of applied microbiology*. Cambridge University Press.
33. Alan Fersht (1999). *Structure and Mechanism in Protein Science*. W H Freeman and Company.

PROGRAMME ELECTIVE - BIOTECHNOLOGY
BY800403: GENOMICS, TRANSCRIPTOMICS, PROTEOMICS AND BIOINFORMATICS
(Theory 90 hrs; Practical 54 hrs; Credits 4)

Module 1: Genome mapping (12 hrs)

(a) Genome map – definition, types, and significance in genomics.

(b) Cytogenetic map – types (Brief study)

(c) Genetic mapping – basic principles for the construction of linkage maps. Markers for genetic mapping – genes, biochemical markers, molecular markers. Construction of linkage maps using molecular markers - RFLP, RAPD, AFLP, SSLP, SNP.

(d) Physical mapping – restriction mapping, STS mapping, EST.

Module 2: Genome sequencing (14 hrs)

(a) Basic steps in genome sequencing. Shot gun sequencing of small genomes. Hierarchical shot gun sequencing. Whole genome shot gun approach.

(b) Sequence assembly – methods used.

(c) Next generation sequencing strategies: Preparation of sequencing library. Reversible terminator sequencing (Illumina sequencing), Pyrrosequencing, 454 sequencing, ion torrent method, SOLiD. Third and Fourth generation sequencing.

(e) Important findings of the completed genome projects: Human genome project, Rice genome project, Arabidopsis genome project, *E. coli* genome project, Wheat genome project.

Module 3: Genome annotation (11 hrs)

(a) Structural annotation: by computer analysis of sequence data and experimental techniques

(b) Functional annotation: by computer based methods and experimental methods

Module 4: Comparative genomics (5 hrs)

Orthologs and Paralogs, gene identification by comparative genomics, comparative genomics as a tool in evolutionary studies. Metagenomics.

Module 5: Transcriptomics (5 hrs)

Components of the transcriptome. Methods of transcriptome analysis and its importance in genome annotation.

Module 4: Proteomics (8 hrs)

Proteome, proteomics. Protein profiling – steps in protein profiling. Protein sequencing. Protein expression analysis using protein microarray, protein localization using GFP.

Module 5: Bioinformatics (27 hrs)

(a) Internet and WWW. National Centre for Biotechnology Information – SRS. Computational Biology and Bioinformatics. Database organization and function. Types of databases based on the data storage pattern. Submission to and retrieval from databases – BankIt and sequin. Secondary Databases (PROSITE, PRINTS, BLOCKS).

(b) Sequence Analysis: Global Alignment, pairwise analysis, Scoring Matrices (an introduction), Database similarity search – query sequence search; BLAST – Algorithm and different versions; FASTA. Multiple Sequence Analysis dynamic programming for sequence alignment. Tools for multiple sequence alignment – CLUSTAL X/W.

(c) Structural Bioinformatics: Molecular Structure viewing tool – Rasmol; Protein structure prediction, secondary structure prediction - Chou Fasman method and other Bioinformatics tools

for secondary structure prediction; Tertiary structure prediction - comparative modeling, Abinitio prediction, Homology modeling.
(d) Gene prediction strategies, ORF search, gene prediction programs – Grail/Exp, GENSCAN, ORF finder. RNA secondary structure prediction.
(e) Computer assisted drug design - concept, methods and practical approaches. Brief study about Docking tools, AutoDock, molegro virtual docker, GOLD.
(f) Applications of bioinformatics in evolutionary studies, molecular clock hypothesis. Molecular Phylogeny – Gene and Species tree. Molecular evolution and Kimuras theory, Phylogenetic Trees, Terminology in Phylogenetic tree. Tree drawing Methods. Cladogram and Phylogram, Significance of Molecular Phylogeny.

Module 6: Ethical, legal, and social impact of complete genome analysis (8 hrs)

Genome data availability – Problems with public availability of sequence data, privacy concerns, legal problems, gene and DNA sequence patenting, patenting transgenics.

Practical (54 Hrs)

1.Blast search with Protein sequence (e.g. *Cytochrome C*sequence)
2. Blast search with Nucleic Acid Sequence (e.g *Magnolia latahensis* & Neanderthal man Paleo DNAs)
3. Carry out multiple sequence alignment using the given DNA sequences.
4. Phylogenetic tree creation with CLUSTAL X, W and MUSCLE and tree viewing tools. NJ Plot, Tree View, MEGA
5. Creation of phylogentic trees for selected families of Eudicots
6. Molecular structure viewing - use of Rasmol (supply structure of a few proteins downloaded from PDB).
7. Locate specific sequences like TATA box, promoters, start signals, stop signals etc. in a DNA sequence using computer programmes e.g., *E. coli* promoter, human promoter.
8. Laboratory/Industry visit: Students are expected to conduct a visit to a sophisticated biotechnology laboratory/research centre/biotechnology industry to have an idea on the type of work going on there. A report of the visit should be prepared and submitted.

References

1. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
2. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.
3. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
4. T A Brown (2018). *Genomes 4*. Garland Science.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics:From genes to genomes* (II Edn). McGraw Hill.
6. *Science*, 16 february 2001, Vol. 291.
7. David W Mount (2001). *Bioinformatics: sequence and genome analysis*. CBS publishers & distributors.
8. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.

9. David P Clark (2010). *Molecular biology*. Elsevier.
10. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
11. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
12. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
13. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.
14. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
15. Paul G Higgs, Teresa K Attwood (2005). *Bioinformatics and molecular evolution*. Blackwell publishing.
16. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
17. T A Brown (2002). *Genomes* (II Edn). Bios.
18. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson
19. George Acquaah (2005). *Understanding biotechnology*. Pearson.
20. Teresa K Attwood, David J Parry-Smith, Simiron Phukan (2007). *Introduction to Bioinformatics*. Pearson Education.
21. Zhumur Ghosh, Bibekanand Mallik (2008). *Bioinformatics: principles and applications*. Oxford University press.
22. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
23. Robert H Tamarin (2002). *Principles of genetics*. McGraw Hill.
24. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (XXVIII Edn). Mc Graw Hill.
25. *Nature*, 409 (6822): 860-921, 2001.
26. S R Pennington, M J Dunn (Edts) (2002). *Proteomics: From protein sequence to function*. Viva Books Private Limited.
27. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
28. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
29. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X*. Jones and Bartlett Publishers.
30.Rocha, M. & Ferreira, P.G. 2018. Bioinformatics Algorithms: 1st Edition. Academic Press.
31. Momand, J. & McCurdy, M. 2017. Concepts in Bioinformatics and Genomics. Oxford University Press.
32.Jeremy, R. 2015. Bioinformatics: An Introduction. Springer Publishing Co.
33.Choudhuri, S. 2014. Bioinformatics for Beginners. 1st Edition. Academic Press

MODEL QUESTION PAPERS - THEORY
M Sc Botany Degree (CSS) Examination
IV Semester
Faculty of Science
Programme Elective - Biotechnology
BY800401. PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1.Differentiate between stirred tank and airlift bioreactors.
2. Define the following;
(a) Totipotency (b) Synseeds (c) Haploids (d) Stem cells
3. What is androgenesis?
4. What are the causes of somaclonal variation?
5. Name four industrial chemicals produced by using microbial activities. Write the names of the microorganisms involved in each.
6. Describe the importance of using tissue culture in producing secondary metabolites.
7. What is enzyme engineering? What are the applications of it?
8. Briefly describe bioaugmentation.
9. How are triploids produced?
10. How do we produce stem cells?

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write an account on the procedure and applications of hairy root culture.
12.Giving suitable examples, discuss downstream processing.
13.What are cybrids? How are they produced? Discuss the use of cybrids in crop improvement programmes.
14.Citing suitable examples, discuss the importance of GMOs in bioremediation
15. Describe the procedure of plant protoplast isolation and purification.
16.Briefly describe the prospects and future of stem cell research.
17.What is germplasm? Describe the methods of germplasm conservation. Add a note on the importance of tissue culture as a method of germplasm conservation
18. Write an account on the methods and applications of cell immobilization.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19.Describe the procedure and applications of;
(a) Cryopreservation (b) Protoplast culture (c) Microspore culture (d) Cellulase production
20. What is enzyme immobilization? Describe the steps involved and the potential applications. Add a note on enzyme engineering.
21. Write an essay on bioremediation.
22. Describe the various tissue culture techniques used to produce ploidy variants in plants.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
IV Semester
Faculty of Science
Programme Elective - Biotechnology
BY800402: GENETIC ENGINEERING, GENOME EDITING AND IMMUNOLOGY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1 Where does T DNA come from, and how is it used in making transgenic plants?
2. Name the key tools for accomplishing the tasks of recombinant DNA technology. Also mention the functions of each tool.
3. Explain the purpose of selectable marker genes in cloning experiments.
4. Explain how edible vaccines work?
5. Distinguish between genomic library and cDNA library
6. What are the advantages of Bt plants?
7. Explain what is meant by the following terms in relation to genetic engineering;
(a) Transformation (b) Polylinkers (c) Lipofection (d) Expression vectors
8. Write the important features in pUC.
9. What is antibody engineering?
10. Comment on gene augmentation therapy.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Describe the following;
(a) BAC (b) DNA probes (c) Electroporation (d) TALEN
12. Highlight any four areas where genetic modification of plants has been useful.
13. What is a recombinant DNA vaccine? Give two examples
14. Explain the gene therapy strategy applied to treat a patient suffering from ADA deficiency.
15. You have identified a useful gene in bacteria. Make a flow chart of the steps that you would follow to transfer this gene to a plant.
16. Describe the important applications of Biosensors.
17. Describe the steps involved in the creation of a genomic library.
18. Comment on RNAi therapy.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. What is monoclonal antibody? How is monoclonal antibody produced in large scale? What are the uses of it?
20. Describe the following;
(a) Plaque hybridization (b) Biopharming (c) *In vitro* mutagenesis (d) Artificial chromosomes
21. 'Genes could be silenced using RNA'. Explain the methods used with examples.
22. Describe the methods and applications of genome editing.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
IV Semester
Faculty of Science
Programme Elective - Biotechnology
BY800403: GENOMICS, TRANSCRIPTOMICS, PROTEOMICS AND BIOINFORMATICS
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is multiple sequence alignment? Where is it useful?
2. What is a DNA marker? Give two examples.
3. Explain how some of the Restriction enzymes produce "sticky ends" while DNA is cut?
4. Write a brief note on metagenomics.
5. Explain the following terms related to drug design;
(a) GOLD (b) ORF (c) SOLiD (d) EST
6. What is STS?
7. Distinguish between a physical map and a genetic map.
8. How is GFP useful for protein localization in a living cell?
9. What are secondary databases? Give examples.
10. What is cladogram?

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Describe the major findings of HGP.
12. What is comparative genomics? How is it useful in determining the evolutionary relationships between organisms?
13. Explain the features of GENSCAN.
14. Explain the working and important features of BLAST?
15. What are the applications of genome sequencing?
16. Describe the following;
(a) Microarrays (b) Immunoprecipitation (c) Knock down mutants (d) SNP
17. Describe the different genome sequencing strategies
18. Describe the strategies adopted for sequence assembly.

(6 x 2 = 12)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe the methods adopted for the annotation of the genome sequence.
20. Write an essay on the ethical, legal, and social issues generated by large-scale sequencing of genomes.
21. Explain the application of bioinformatics in evolutionary studies
22. Write an essay on the different types of genome mapping techniques.

(2 x 5 = 10)

MODEL QUESTIONS - PRACTICAL
ELECTIVE - BIOTECHNOLOGY
BY800404: PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY

Time: 4 hours **Weightage:30**

1. Selective isolation of amylase producing microbes from environment
(Total weight 6:Procedure – 2; Experiment – 2; Comment/Interpretation – 2)
2. Isolate early stage embryo from the given material in aseptic conditions and inoculate in the medium
(Total weight 5:Procedure – 2; Isolation – 1; Inoculation – 2)
3. Prepare synthetic seeds by inserting somatic embryo/zygotic embryo/axillary bud/apical meristem in Sodium alginate
(Total weight 5: Procedure – 2; Working/Preparation - 3)
4. Select the anther in appropriate stage for anther culture. Write down the selection criteria for the flower bud.
(Total weight 4: selection criteria – 1; Preparation – 3)
5. Comment on A, B, C, D, E and F.
(Weight 1; 1 x 6 = 6)
6. Practical record
(Weight 4)

Key to the questions:
1**.** Preparation of plates and isolation of microbe has to be done 2-3 days before exam.
2. Give appropriate seeds
3. Give necessary reagents and materials
4. Give appropriate inflorescence
5. A, B, C, D, E, F - Chemicals, Instruments, Photographs/Diagrams related to tissue culture/microbial biotechnology procedures specified in the syllabus
6.Awarding 'A grade' to the record of practical work shall be considered only if all the practicals specified in the syllabus are completely done and recorded properly.This also includes field study report(s)/Lab visit report(s)/Industry visit report(s), if any.

SEMESTER IV - PRACTICAL COURSE II
BY800405: GENETIC ENGINEERING, GENOME EDITING, IMMUNOLOGY, GENOMICS, TRANSCRIPTOMICS, PROTEOMICS AND BIOINFORMATICS
Model question paper

Time: 4 hours **Weightage: 30**

1. Find out the phylogenetic relationship of *Homo sapiens neanderthalensis* Cytochrome Cprotein sequence with other 5 organisms.
(Total weight 5: Processing of the source file containing FASTA format – 1; MSA output – 2; Tree Creation - 2)
2. Blast search with the given nucleotide sequence (e.g.*Magnolia latahensis* sequence). Using the same sequences, carry out multiple sequence alignment.
(Total weight 5: Identification and FASTA sequence of phylogenetically related organisms – 1.5; BLAST SEARCH – 1.5; MSA output – 3)
3. Isolation DNA from the given plant material.
(Total weight 5: protocol – 1; Isolation – 4)
4. Separate Nucleic acid by agarose gel electrophoresis
(Total weight 5: Running efficiency – 3; Band vision – 2)

5. Comment on A, B, C and D
(Weight 1.5; 1.5 x 4 = 6)
6. Practical record
(Weight = 4)

Key to the questions:
1. Draw a phylogenetic tree using the gene sequence data file with the help of CLUSTAL X/W or MUSCLE and tree drawing tool
Centre can provide raw genesequences of phylogenetically related organisms as a Text file.
2. Download protein sequences like Magnolia latahensisrbcL gene from genbank and save it in each desktop. Then use Clustal X/MUSCLE
3. Supply necessary tissue samples
4. Supply pure samples of DNA/RNA, and necessary buffer
5. A, B, C, D - Vectors, procedures or equipments (photographs) used in genetic engineering
6. Awarding 'A grade' to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely recorded properly. This also includes field study report(s)/Lab visit report(s)/Industry visit report(s), if any.

PROGRAMME ELECTIVE – MICROBIOLOGY

BY810401: FOOD, AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

(Theory 35+20+35 Hrs: Practical 72 Hrs; Credits: 4

FOOD MICROBIOLOGY (35 hrs)

Module 1: Introduction (3 hrs)

Scope of food microbiology.Food as a substrate. Microorganisms and food – Bacteria, Yeasts and Moulds. Factors influencing microbial growth in food (Intrinsic and Extrinsic)

Module 2: Food spoilage and detection of spoilage. (4hrs)

Food Spoilage -General principles underlying food spoilage and contamination.Spoilage of canned food, sugar products, vegetable, fruits, meat and meat products, milk and milk products fish, seafood and poultry.Detection of food spoilage-organoleptic, microbiological and chemical. Culture and non-culture based detection of food spoiling microorganisms.

Module 3: Food Preservation (4 hrs)

Principles of food preservation – Asepsis, removal of microorganisms, anaerobic conditions, high and low temperatures, drying, irradiation.Chemical and bio preservatives and food additives.Food packaging & labeling.

Module 4: Microbiology of fermented food (9 hrs)

Starter cultures their biochemical activities, production and preservation of the following fermented foods (i) Oriental fermented foods (Soy Sause) (ii) Fermented Milk products-Cheese, yogurt and Indigenous dairy products in India (iii) Alcoholic fermentation by Yeast- Wine (iv) Fermented vegetables – Sauerkra (v) production of apple cider vinegar.

Application of microbial enzymes in food industry**.** Probiotics-production and applications

Module 5: Food borne diseases (9 hrs)

Diseases caused by spoiled foods and food additives. Food borne diseases caused by bacteria - Salmonellosis, Gastroenteritis, Shigellosis, Listeriosis, Staphylococcal food poisoning, Botulism, Travellers' diarrhoea. Fungal intoxication - Aflatoxin and related components. Virus intoxication.

Module 6: Food quality (6 hrs)

Factors affecting food quality-composition, spoilage, colorants, additives, nutrients, flavorants and contamination.Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK, ISO22000. Food research organizations/institutes in India.

AGRICULTURAL MICROBIOLOGY (20 Hrs)

Module 1: Microbes as Biofertilizers (14 hrs)

a) Microbes as biofertilizers - bacteria, fungi and algae. Production of biofertilizers - strain selection and preparation of biofertilizers. Microbes producing antimicrobial agents, siderophores.
b) Nitrogen fixing microbes – free living organotrophs, free living prototrophs and diazotrophs. Association of microbes with legumes, nodulation process in legumes; nif gene. Azolla-Anabaena association.
c) Phosphate solubilizers – Bacteria and fungi as phosphate solubilizers. Mycorrhizal relationship – definition, forms and distribution of mycorrhiza. Ecto- and Endomycorrhiza. Vescicular and Arbuscular mycorrhiza, Ericaceous, Orchidaceous mycorrhiza. Physiology and function of mycorrhiza. Production of mycorrhizal biofertilizers. Root exudates, rhizophere and rhizophere effect.

Module 2: Microbes as Bio pesticides (4 hrs)

Bacterial insecticides - use of Pseudomonas and Bacillus. Viral insecticides. Entomopathogenic fungi. Microbial herbicides

Module 3: Enrichment of soil micro flora (2hrs)

Sustainable agriculture, organic farming, crop rotation and legume planting (brief account)

ENVIRONMENTAL MICROBIOLOGY (35 Hrs)

Module 1: Microbial Diversity (3 hrs)

Microbial communities and ecosystems: Microbial community dynamics and structure of microbial communities.Microbes in extreme environments: Habitat, biodiversity, adaptive strategies and biotechnological potential of thermophiles and hyperthermophiles, psychrophiles and psychrotrophs, halophiles, acidophiles and alkalophiles.

Module 2: Methods in Microbiology (10 hrs)

(a) Methods of studying microbial diversity (Conventional and molecular tools)

(b) Isolation and cultivation of microbes from environment - serial dilution and pour plate method, spread plate method, streak plate method, isolation using selective or enrichment media. Methods of culturing anaerobes.

(c) Culture characteristics of microbes. Bacterial growth curve, staining techniques. Biochemical tests for bacterial identification - carbohydrate fermentation, triple sugar-Iron agar test, IMVIC test, Litmus Milk reactions, Hydrogen sulphide test, Catalase test, Oxidase test.

Module 3: Soil and Aquatic Microbiology (9 hrs)

(a) Soil as a habitat for microbes. Factors influencing soil microbial growth. Microorganisms and the formation of different soils – tropical soil, temperate soil, bog soil, cold moist area soil, desert soil, geologically heated hyper thermal soil.

(b) Microbes and their role in fresh water, brackish water and marine environments. Contamination of aquatic environment by pathogenic microbes. Detection of coliform bacteria - membrane filtration technique, multiple tube fermentation tests. Quantification of Coliforms - MPN test.

(c) Waste water treatment - primary, secondary and tertiary treatment.

Module 4: Microbes and Environment (8hrs)

Biogeochemical cycles: Role of microorganisms in Carbon, Nitrogen, Sulfur and Phosphorous cycles. Microbes as pollution indicators. Biological magnification. Role of microbes in the disposal of waste and production of organic compost and biogas. Microbial leaching; microbial biofilm.

Module 5: Microbial Technology. (5 hrs)

Bioremediation - microbial and enzymatic; *in situ* and *ex situ.* Microbial bioremediation of petroleum, heavy metals and pesticides. Bio-augmentation – principles, enzymes used in bio-augmentation, bio-filtration-bio-filters, microorganisms used in filters, mechanism of bio-filtration, phyto-extraction and phyto transformation. Genetically modified microbes - benefits and hazards. Metagenomics

Practical (72 hrs)

1. Isolation of microorganisms from different sources – air and water.
2. Isolation of microbes by serial dilution and pour plate/ spread plate method
3. Isolation of microbes by streak plate method
4. Microbiological examination of foods.
   (i) Isolation and enumeration of bacteria and fungi from fresh and spoiledfruits.
   (ii) Isolation and enumeration of bacteria and fungi from fresh and spoiledvegetables.
   (iii) Isolation and enumeration of bacteria from fruit juices.
5. Effect of food preservatives on the growth of microbes.
6. IMVIC test

7. Oxidase test
8. Catalase test
9. Litmus milk test
10. Hydrogen sulphide test
11. Carbohydrate fermentation test
12. Multiple tube fermentation test
13. Methylene blue reductase test for milk
14. Molility by hanging drop method
15. Detection of siderophore production by bacteria
16. Estimation of mycorrihzal colonization in roots
17. Isolation of Azotobacter from soil

References:

1. Alcamo (1994). Fundamentals of microbiology. Benjamin/Cummings pub.
2. Alexander M (1977) *Introduction to soil microbiology* (Wiley, New York ; London) 2nd ed.
3. Atlas RM & Bartha R (1998) *Microbial ecology : fundamentals and applications* (Benjamin/Cummings, Menlo Park, Calif.; Harlow) 4th ed.
4. A S Rao (1988). *Introduction to microbiology*. Prentice-hall pub. Com
5. Bibek Ray & Arun K. Bhunia. Fundamental Food Microbiology. CRC Press. 1996
6. Campbell RE (1983) *Microbial ecology* (Blackwell Scientific Publications, Oxford ; Boston) 2nd ed
7. Dart RK(1980) *Microbiological aspects of pollution control* (Elsevier Scientific, Amsterdam)2nd ed
8. Frazier, W.C. and Westhoff, D.C. Food Microbiology 4th Edn. TATA McGraw Hill Publishing companyltd., New Delhi. 1988
9. H D Kumar, Swasti Kumar (2001). *Modern concepts of microbiology*. Vikas pub. House
10. H S Chawla (2005). *Introduction to biotechnology*. Oxford/IBH pub Com
11. James M. Jay & Martin J. Loessner & David A. Golden. Modern Food Microbiology Seventh Edition.Springer. 2005
12. Martin R. Adams & Maurice O. Moss. Food Microbiology. Royal Society of Chemistry. 2008Mitchell R (1974) *Introduction to environmental microbiology* (Prentice-Hall, Englewood Cliffs, N.J.,)

13. Pandey,B.P. (2001) *Plant Pathology: Pathogen and Plant Disease.* S.Chand & Co
14. Rangaswami, G., Bagyaraj, D.J. (2007) *Agricultural Microbiology* 2nd edition Prentice Hall publishers
15. Rao NSS (1995) *Soil microorganisms and plant growth* (Science Publishers, Inc.; New Hampshire, U.S.A) 3rd ed. Rheinheimer G (1991) *Aquatic microbiology* (John Wiley and Sons) 4th ed.
16. Nester,E W, Anderson,D.G and Roberts (2012). Microbiology A Human Perspective.
17.Sharma, P.D. (2012) *Plant Pathology*. Rastogi publication
18.Prescott(2002). *Microbiology.* Mcgraw Hill pub.

PROGRAMME ELECTIVE - MICROBIOLOGY

BY810402: CLINICAL MICROBIOLOGY

(Theory 90 Hrs + Practical 54 Hrs; Credits: 4)

Module 1: Immunology (20 hrs)

Cells and organs of immune System- stem cells, lymphoid cells, clinical uses of stem cells. B-lymphocytes,T-lymphocytes. Development of B and T cells. Phagocytosis, Granulocytic cells. Organs of immune system-primary and secondary lymphoid organs.

Module 2: Antigens and Antibodies (8 hrs)

Types, Basic structure of immunoglobulins, classes of immunoglobulins, B-cell receptors and T-cell receptors. Monoclonal antibodies and clinical uses. Genetically engineered antibodies.

Module 3: Antigen antibody reactions (8 hrs)

Antigen antibody reactions- in vivo and *in vitro*. Toxin neutralization, immune complex formation, Agglutination, ELISA, immunoblotting, flow cytometry immunofluorescence and radioimmunoassay.

Module 4 Immune disorders and therapy (8 hrs)

Acute rheumatic fever, type I diabetes mellitus and multiple sclerosis. Interferon, Vaccines, DNA-vaccines, edible vaccines. Autoimmunity- autoimmune diseases. Transplantation immunology-graft rejection and Suppression of graft rejection.

Module 5: Diagnosis of Microbial Diseases (12 hrs)

Collection, transport and preliminary processing of clinical pathogens. Clinical, Microbiological, Immunological and Molecular Diagnosis of microbial diseases. Modern methods of microbial diagnosis.

Module 6: Viral Diseases (16 hrs)

(a) Epidemiology of common viral diseases in humans. HIV, Hepatitis B and C,HPV, Nipah(NiV), Ebola (EBOV). Isolation and maintenance of viruses, methods for detection and assay, phage typing.

(b) Anti-viral strategies: Prevention and control of viral diseases: Host specific and nonspecific defense mechanisms (molecular level) involved in resistance to virus infections and recovery. Role of interferon in viral infections. Contributions of various host defense mechanisms in viral infections. Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitor

Module 7: Bacterial Diseases (16 hrs)

(a) Epidemiology of common bacterial diseases in humans.(Diphtheria, cholera, typhoid, meningitis leptospirosis and Campylobacteriosis) Normal microbiota of human body; host-parasite relationship in baterial pathogenicity: non-specific mechanisms of host defense, mechanism of bacterial virulence, genetics of bacterial virulence; chemotherapy.

Antibiotics - origin, classification, chemistry and mode of action; semisynthetic antibiotics.

Antibiotic resistance in bacteria, mechanism of antibiotic resistance. Common bacterial vaccines

Module 8: Fungal and Protozoan Diseases in Humans (2 hrs)

Epidemology of common fungal and protozoan diseases in humans. (Malaria, Aspergillosis, Candidiasis and Ringworm).

Practical (54 Hrs)

1. Techniques for collection of clinical specimens for microbiological analysis-Macroscopic, microscopic examination of clinical samples. Culture methodsidentification and antibiotic sensitivity test of isolates
2. Double diffusion agar assay (Ouchterlony technique).
3. Staining of bacteria - Gram staining.
4. Spore staining of bacteria.
5. Staining of capsule in bacteria.
6. Staining of lipid granules in bacteria – Burdon’s method.
7. Antibiotic sensitivity test for bacteria.
8. Blood grouping

References

1. Blair, J.E.e., Lennette, E.H.e., and Truant, J.P.e. (1970). Manual of clinical microbiology American Society for Microbiology, Bethesda, Md.
2. Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld. Bailey & Scott's Diagnostic Microbiology, 12e 2007
3. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition. Williams and Wilkins, Baltimore.
4. C.K. Jayaram Paniker, R. Ananthanarayan. Ananthanarayan and Paniker's Textbook of Microbiology.Universities Press (India) Pvt. Ltd., Orient Longman Limited. 2009
5. C Varma Rao. *Immunology.*
6. Lansing M Prescott. *Microbiology.*
7. F H Kayser, K A Bienz, J Eckert, R M Zinkernagel. *Medical Microbiology.*

8. Gradwohl, R.B.H., Sonnenwirth, A.C., and Jarett, L. (1980). Gradwohl's clinical laboratory methods and diagnosis. Mosby, London.8th ed 53
9. Lennette, E.H., Balows, A., Hausler, W.J., and Shadomy, H.J. (1985). Manual of clinical microbiology. American Society for Microbiology, Washington, D.C. 4th ed.
10. L R Haahelm, J R Pattison, R J Whitley. *Clinical virology.*
11. Julius M Cruse, Robert E Lewis. *Atlas of immunology.*
12. Kuby. *Immunology.*
13. Bilgrami, Sinhah. *Essentials of Microbiology.*
14. Purohit. *Microbiology: Fundamentals and applications.*
15. Pelczar, Chan, Krieg. *Microbiology.*

PROGRAMME ELECTIVE - MICROBIOLOGY

BY810403: INDUSTRIAL MICROBIOLOGY

(Theory 90 Hrs; Practical 54 Hrs; Credite: 4)

Module 1: Introduction to Industrial Microbiology (4 hrs)

Historical account of microbes in industrial microbiology, Sources and characters of Industrially potent microbes.

Module 2: Isolation, Selection and maintenance of microbial strains (10 hrs)

Isolation of industrially important microorganisms - primary and secondary screening. Detection and assay of fermentation products -physical-chemical, biological assays. Preservation of microbes – storage at reduced temperature, storage in dehydrated forms.

Module 3: Types of fermentation (10 hrs)

Industrial fermentations. Types of fermentations. Components of fermentation process, Media for industrial fermentation, sterilization, inoculum preparation, raw materials used inindustrial fermentation media, antifoam agents, Solid substrate fermentation (SSF) - Principles and application, Submerged Fermentation. Aerobic and anaerobic fermentation, Problems in fermentation process and handling.

Module 4: Bioreactors (12 hrs)

Fermentor – parts, design, construction and types, Pneumatically driven, hydrolytically driven, mechanically driven, CSTR, Airlift, Packed Bed, Fluidized Bed, Monitoring and control of fermentors, Control of physical and chemical conditions, online and off line instrumentation, pH, temperature, DO probes. Solid state fermentation.

Module 5: Fermentation Process (12 hrs)

(a) Sterilization - media, fermenter, air.

(b) Inoculum preparation, inoculation.

(c) Aeration, agitation, pH control, temperature control, antifoam agents.

(d) Process parameter optimization: One factor at a time and statistical optimizations (brief study only).

(e) Scale up of fermentation (lab scale, pilot plant, industrial scale).

Module 6: Downstream processing (12 hrs)

(a) Separation of microbial cells – Filtration, precipitation, centrifugation.

(b) Cell disruption – liquid shear, freezing-thawing, ultrasonication, osmotic shock, enzyme treatment.

(c) Concentrating and purifying the products - ultrafiltration, crystallization, solvent precipitation, reverse osmosis, chromatography.

Module 7: Production of industrially important products (24 hrs)

(a) Antibiotics - Penicillin, Streptomycin.

(b) Amino acids - Lysine, Glutamic acid.

(c) Enzymes - Amylase, Cellulase, Pectinase.

(d) Organic acids - Lactic acid, Acetic acid, Gluconic acid.

(e) Biofuels – Bio-ethanol, Bio-butanol.

(f) Biopolymers - PHB, PLA.

(g) Alcoholic beverages - Wine, Beer.

(h) Microbial cells - SCP, Baker's yeast.

Module 8: Immobilization of cells and enzymes (6 hrs)

Methods of cell and enzyme immobilization. Applications of immobilized cells and enzymes.

Practical (54 hrs)

1. Screening and isolation of microbes for production of organic acids and enzymes.
2. Preparation and maintenance of stock cultures (Bacteria and Fungi).
3. Preparation of fungal spore inoculum and enumeration of spores by Hemocytometer.
4. Preparation of bacterial inoculum by measuring OD and enumeration of bacterial cells by serial dilution and pour plate (or spread plate) method.
5. Solid state and Submerged fermentation for amylase (or any other enzyme) production and quantification of product by suitable assay methods.
6. Optimization of process parameters for enzyme production in submerged fermentation.
7. Partial purification of amylase (or any other enzyme) produced by microbial fermentation using acetone precipitation.
8. Lab level production of metabolites (Wine, Vinegar).
9. Immobilization of yeast cells and sugar fermentation using immobilized cells.

References

1. L E Casida. *Industrial Microbiology.*
2. Peter F Stanbury, Allan Whitaker. *Principles of Fermentation technology.*
3. Ronald M Atlas. *Basic and Practical Microbiology.*
4. R C Dubey, D K Maheshwari. *A text book of Microbiology.*
5. Richard G Burns, J Howard Slater. *Experimental Microbial Ecology*.
6. Arnold L Demain, Julian E Davies. *Manual of Industrial Microbiology and Biotechnology.*
7. Rita Singh, S K Ghosh. *Industrial Biotechnology.*
8. John I D'Souza, S G Killedar. *Biotechnology and Fermentation process*.
9. Michael J Waites, Neil L Morgan, John S Rockey, Gary Higton. *Industrial Microbiology: Anintroduction.*
10. A H Patel. *Industrial Microbiology*.

11. Wulf Crueger, Anneliese Crueger. *Biotechnology: A text book of industrial microbiology*.
12. B McNeil, L M Harvey. *Practical fermentation technology*.
13. Henry C Vogel, Celeste L Todaro. *Fermentation and biochemical engineering handbook*.
14. S C Prescott, Cecil Gordon Dunn. *Industrial Microbiology*.
15. Mansi EL-Mansi, Charles F A Bryce. *Fermentation microbiology and Biotechnology*.

MODEL QUESTION PAPERS

M Sc Botany Degree (C.S.S) Examination

Fourth Semester

Faculty of Science

Programme Elective – Microbiology

BY810401: FOOD, AGRICULTURE AND ENVIORNMENTAL MICROBIOLOGY

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Explain asepsis.
2. Write down the role of *aspergillus* in food spoilage
3. Describe salmonellosis.
4. Write short note on travellers' diarrhea.
5. What are the principles of HACCP?
6. Define psychrophiles.
7. Write a brief account on nif genes.
8. What is bioremediation?
9. Explain MPNtest.
10. Describe microbial leaching

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Write a brief account on fermented vegetables.
12. Explain the role of microbes as biopesticides
13. What is fungal food intoxication?
14. Write short note on Food Research Organization in India.
15. Explain the role of phosphate solubilizing microorganisms.
16. Describe the production and application of probiotics.
17. Explain the role of microbes in sulphur cycle.
18. What is bioaugmentation?

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Explain food spoilage and detection of food spoilage by various methods.
20. Explain briefly mechanism of biological nitrogen fixation.
21. Write an essay on biochemical test for bacterial identification mentioned in your syllabus.
22. What are the general principles underlying food preservation?

(2 x 5 = 10)

M Sc Botany Degree (C.S.S) Examination

Fourth Semester

Faculty of Science

Programme Elective – Microbiology

BY810402: CLINICAL MICROBIOLOGY

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight**questions. Each question carries a weight of 1)

1. What are B lymphocytes?
2. Write short note on immunoglobulins.
3. What is ELISA?
4. Define DNA vaccines.
5. Explain Nipah (niV).
6. Define interferon
7. Describe leptospirosis
8. Define candidiasis
9. Write shortnote on phagocytosis.
10. What are semisynthetic antibiotics?

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Describe the protozoan disease in humans
12. What are chemotherapeutic agents? Name any four agents and mention its mode of action.
13. Illustrate the structure of HIV and its transmission.
14. What are the modern methods of microbial diagnosis?
15. Briefly explain the auto immune diseases.
16. Write short note on radio immunoassay.
17. What are genetically engineered antibodies?
18. Explain the clinical uses of stem cells.

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Write an essay on organs of immune system with special reference to primary and secondary lymphoid organs
20. Explain antigen antibody reactions
21. Write an essay on immunological and molecular diagnosis of microbial disease
22. Write an essay on prevention and control of viral diseases

(2 x 5 = 10)

M Sc Botany Degree (C.S.S) Examination

Fourth Semester

Faculty of Science

Programme Elective – Microbiology

BY810403: INDUSTRIAL MICROBIOLOGY

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Explain SSF.
2. Write short note on maintenance of microbial strains.
3. What are antifoam agents?
4. Define reverse osmosis.
5. Write short note on bio fuels.
6. Explain PHB.
7. Write short note on baker's yeast.
8. Define SCP.
9. Write a short account on enzyme immobilization.
10. Describe Airlift fermenter.

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. What are the characters of industrially potent microbes?
12. Write short note on isolation of industrially important micro organisms
13. What are the steps involved in media preparation for industrial fermentation?
14. Define scale up fermentation
15. Write short note on cell disruption method.
16. What are biopolymers? Explain its role.
17. Describe microbial production of penicillin
18. Illustrate the design of a bioreactor.

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Explain different types of fermenters and fermentation techniques.
20. Write an essay on selection and strain improvement strategies.
21. Briefly explain downstream processing in fermentation.
22. Write an essay on methods of cell and enzyme immobilization and its applications

(2 x 5 = 10)

ELECTIVE – MICROBIOLOGY
BY810404: PRACTICAL COURSE I
FOOD, AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY

Time: 4 hours **Weightage: 30**

1. Conduct IMVIC test of Bacteria (A). Any 3 tests.

(Total weight3: Procedure – 1; Result – 2; 3 x 3 = 9)

2. Calculate the percentage of Mycorrhizal colonization in the given sample B.

(Total weight 4: Preparation – 2; Procedure-1; calculation – 1)

3. Demonstrate methylene blue reductase test (C).

(Total weight 3: Procedure – 1; Experiment – 2)

4. Demonstrate motility of microbes (D) with a hanging drop culture.

(Weight 3: procedure -1; working -2)

5. Demonstrate Catalase activity of the microbes E.

(Total weight 3: Working – 1; Procedure – 1; result- 1)

6. Comment on F, G, H and I.

(Weight 1; 1 x 4 = 4)

7. Practical record.

(Weight 4)

Key to the questions:
1. A - Bacterial culture is to be supplied.
2. B - supply roots fixed in FAA.
3. C - supply milk samples
4. D - root nodules or any bacterial culture.
5. E - 12 hr. old bacterial cultures – one culture positive to catalase activity and another culture negative to catalase activity.
6. F, G, H and I - Equipment/Cultures/Reagents/Diagrams etc., belonging to microbiology topics covered in the syllabus.
7. Awarding 'A grade' to the record of practical work shall be considered only if all the practicals Specified in the syllabus are completely done and recorded properly. This also includes field study report(s)/Lab visit report(s), if any

ELECTIVE – MICROBIOLOGY
BY810405: PRACTICAL COURSE I
CLINICAL MICROBIOLOGY AND INDUSTRIAL MICROBIOLOGY
Time: 4 hours **Weightage: 30**

1. Solid state and submerged fermentation (SSF) for amylase production and quantification of amylase produced (A).
(Total weight 6: Experiment – 2; Procedure 2; Result 2)
2. Identify the Bacterial types B and C by Gram staining.
(Total weight 3: Procedure – 1; Preparation – 1; Identification – 1; 2 x 3 = 6)
3. Stain Bacterial spores D supplied.
(Total weight 4: Preparation – 2; Procedure – 2)
4. Determine the blood group of sample E.
(Total weight4: Preparation – 2; Procedure – 2)
5. Comment on F, G, H and I.
(Weight 1.5; 1.5 x 4=6)
6. Practical record
(Weight 4)

Key to the questions:
1. A - 4 days old fungal culture (SSF) should be supplied
2. B, C – unknown bacterial cultures are to be given.
3. D – old bacterial culture having spores
4. E – any blood sample
5. F, G, H and I – Equipments/Cultures/Reagents/Diagrams related to topics covered in the syllabus.
6. Awarding 'A grade' to the record of practical work shall be considered only if all the practicals Specified in the syllabus are done completely and recorded properly. This also includes field studyreport(s)/Lab visit report(s), if any

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY820401: BASIC CONCEPTS IN ENVIRONMENTAL STUDIES

(Theory 90 Hrs; Practical 72 Hrs; Credits 4)

Module 1: History (5 hrs)

History of development of environmental science, scope and significance of environmental studies. Concept of the sustainable world.

Module 2: Natural environment (7 hrs)

(a) Origin and structure of earth – primary differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.
(b) Biological environment: Biosphere – hierarchies in the biosphere.

Module 3: Earth and its atmosphere (18 hrs)

(a) Physical environment: Lithosphere, Hydrosphere, Atmosphere.
(b) Land and water systems: Weathering and erosion process, types and formation of soils and soil profile. Physical, chemical and biological properties of soil. Causes, effects and control of earthquakes, volcanoes, landslides, floods and storms.
(c) Aquatic environment: Hydrologic cycle, diversity of aquatic habitats. Aquatic food web and factors affecting primary productivity. Groundwater – occurrence, chemistry; salt water intrusion.
(d) General characteristics of freshwater environment: Lentic systems; Lakes – origin and classification, ecological zonation, water circulation. Lotic systems - Ecology of streams and rivers.
(e) General characteristics of marine environment: Ocean - chemistry of sea water, circulation and ecological zonation in sea, marine biota, primary productivity, coral reefs and marine resources.
(f) Eutrophication: Causes and consequences, methods of control.

Module 4: Weather and Climate (20 hrs)

(a) Definitions and scope of climatology, weather and climate. Components of climate system.
(b) Earth's thermal environment, Air temperature in relation to altitude. Global circulation of air masses, wind and earth's rotation on ocean currents, influence of temperature on moisture content of air, global pattern of precipitation, influence of topography on regional pattern of precipitation.
(c) Classification of climate - Koppen's classification and Thornthwaite's scheme, climatic types and zones.
(d) Global climatic phenomena - *El Nino* and *La Nina*, causes and factors of climate change. Effect of climate change on ecosystems and human life., organisms and microclimate.
(e) Climate of India: Climatic regions of India, Monsoon in Kerala. Short illustration on cyclones affected in peninsular India.
(f) Climate change – causes and effects.

Module 5: Ecosystems (20 hrs)

(a) Ecosystem organization: Structure and function of ecosystem components. Processes in ecosystem: Primary production – methods of measurement, global pattern, controlling factors. Nutrient cycles, energy flow, biogeochemical cycles, trophic relations, productivity and ecological efficiencies and ecological niche

(b) Structure, function, and characteristics of; (i) Forests and tundras – temperate and tropical forests, arctic and alpine forests (ii) Deserts – arid and semi-arid (iii) Grassland and savannas (iv) Coastal and marine (v) coral reefs (vi) Estuaries: Definition, types, biotic communities and productivity; environmental significance of estuaries. (vii) Mangroves.
(c) Wetlands: Ramsar Convention, Ramsar sites. Different kinds of wetlands: Shallow Freshwater Wetlands, Tropical Marshes, Tropical Swamps, Inland Saline Wetlands, Salt Marshes, Mangrove Swamps, Kol Lands of Kerala. Climate change and wetlands, wetland conservation.

Module 6: Community Ecology (10 hrs)

(a) Communities: Structure, ecological processes of community formation, ecotone, edge effect types and characters of communities, community gradients. Global pattern of species richness, species diversity.
(b) Dynamics of community development

Module 7: Population ecology (10 hrs)

(a) Population characteristics, population growth, carrying capacity, population regulation, population differentiation.
(b) Population interactions: Mutualism, proto-cooperation, commensalism, competition, co-existence, predation, herbivory and parasitism
(c) Evaluating the controls on population size. Trends in human population growth. Problems with overpopulation.

Practical (72 hrs)

1. Qualitative and quantitative study of freshwater/marine planktons
2. Soil texture using micrometry from two different sites. Principle and explanation
3. Determination of moisture content.
4. Determination of soil pH from at least three different locations and correlate it with the soil type
5. Determination of chloride, calcium, magnesium, potassium and phosphorous.
6. Estimation of primary productivity in two different aquatic ecosystems and interpretation of the results. Compare the results of Dark and Light bottle method and Chlorophyll method.
7. Study of biodiversity in Forest/Grass land and Pond/River and report the species richness, abundance and animal interactions. Calculate frequency, abundance, evenness and diversity indices.
8. Identification of plants growing in different habitats and studying their adaptations

References

1. Alongi D M (1998). *Coastal Ecosystem Processes*. CRC Press.
2. Chapman G P (1977). *Human and Environmental Systems: A Geographer's Appraisal*. Academic Press.
3. Chapman J L, Reiss M J (2005). *Ecology: Principles and Applications.* Cambridge University Press.
4. Elton C S (1958). *The Ecology of Invasion by Plants and Animals.* Methuem, London.
5. Forman R T (1995). *Land Mosaics: The Ecology of Landscapes and Regions.* Cambridge University Press.
6. Forman R T T, Godron M (1986). *Landscape Ecology.* John Wiley & Sons.

7. Fox C W, Roff D A, Fairbairn D J (Eds) (2001). *Evolutionary Ecology: Concepts and Studies.* Oxford University Press.
8. Jorgensson S E. (2009). *Ecosystem Ecology*, Elsevier.
9. Krebs C J (2008). *Ecology: The Experimental Analysis of Distribution and Abundance* (VI Edn). Benjamin Cummings Publ.
10. Krishnamurthy K (2004). *An Advanced Textbook on Biodiversity: Principles and practice*Oxford and IBH. Publ. Co.
11. Levin S A (Ed) (2000). *Encyclopedia of Biodiversity*. Academic Press.
12. Mayhew P J (2006). *Discovering Evolutionary Ecology: Bringing Together Ecology and Evolution*. Oxford University Press.
13. Miller G T (2004). *Environmental Science.* Thomson.
14. Nagelkerker, I. (2009*). Ecological connectivity among tropical coastal ecosystems*, Springer.
15. Odum E P, Barrett G W (2005). *Fundamentals of Ecology*- 5th Edition. Brooks/Cole Publishing Co.
16. Osborne P L (2012). *Tropical Ecosystems and Ecological Concepts*, 2nd edition. Cambridge University Press
17. Pianka E R (2000). *Evolutionary Ecology* (VI Edn). Benjamin Cummings.
18. Primack R B (1998). *Essentials of Conservation Biology*. Sinauer Associates.
19. Pullin A S (2002). *Conservation Biology*. Cambridge University Press.
20. Ramakrishnan P S (1991). *Ecology of Biological Invasion in the Tropics*. International Scientific Publications.
21. Ramakrishnan P S (1992). *Shifting Agriculture and Sustainable Development*. UNESCO, MAB, Paris.
22. Rana S V S (2005). *Essentials of Ecology and Environmental Science*. Prentice Hall of India.
23. Rose M R, Mueller L D (2006). *Evolution and Ecology of the Organisms*. Pearson Prentice Hall.
24. Singh J S, Singh S P, Gupta S R (2006). *Ecology, Environment, and Resource Conservation. Anamaya Publ.*
25. Smith T M Smith R L. (2012). *Elements of ecology*, 8th edition, Benjamin Cummins.
26. Soule M E (Ed.) (1986). *Conservation Biology*. Sinauer Associates.
27. Steiner F (1999). *The Living Landscape: An Ecological Approach to Landscape Planning* (II Edn). McGraw Hill Inc.
28. Williamson M (1996). *Biological Invasion*. Chapman & Hall.
29. www.ramsar,org
30. Moore P D (2008). *Wetlands.*Infobase publishing.
31. McIlveen R (2010). Fundamentals of weather and climate, 2nd edition. Oxford.

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY820402: NATURAL RESOURCES AND THEIR MANAGEMENT
(Theory 90 hrs; Practical 54 hrs; Credits 4)

Module 1: Natural resources and their management (4 hrs)

Natural resources – renewable and nonrenewable. Preservation, conservation, and restoration of resources. Recycling, reuse, and substitution.

Module 2: Principles of resource management – Water resources (8 hrs)

Distribution of water resources, threats to water resources. Principles and approaches to surface water management, watershed management – catchment infiltration models, rainwater harvesting and storage, recharging of ground water. Management of degraded water resources. Drinking water quality and water treatment - desalination, ion-exchange, reverse osmosis, and disinfection of water.

Module 3: Principles of resource management – Energy resources (10 hrs)

(a) Energy sources – resource and reserves. Current national and global energy scenario.
(b) Fossil fuels: Oil, Coal, Natural gas, Shale – sources, exploration, exploitation; environmental consequences of overexploitation.
(c) Nuclear energy: Nuclear fission and fusion, nuclear minerals, nuclear fuel cycle, nuclear fuel production, nuclear reactors. Advantages and disadvantages of nuclear power. Environmental consequences – safety, terrorism, waste disposal and management.
(d) Renewable and alternate energy sources; solar energy, photovoltaic cells; hydropower; tidal power; wind power; geothermal energy; ocean energy; fuel cells – advantages and disadvantages, environmental consequences.
(e) Bio-energy: biomass as energy source, biomass production, energy farming, biomass conversion processes – thermochemical and biochemical. Biodiesel. Environmental consequences of biomass resource harnessing.

Module 4: Principles of resource management – Land resources (4 hrs)

Land as a resource, land degradation and its causes, desertification – causes and prevention.

Module 5: Principles of resource management – Food resources (5 hrs)

Food sources, effect of agriculture on the environment. World food problems, methods and strategies to alleviate food problems.

Module 6: Principles of resource management – Mineral resources (5 hrs)

Mineral resources: Formation of mineral deposits. Types of mineral resources, environmental impact of mineral exploration, mining, processing and utilization. Conservation of mineral resources.

Module 7: Principles of resource management – Biological resources (34 hrs)

(a) Forests as biological resources – importance, types of forests, deforestation, reforestation, conservation of forests.
(b) Biodiversity and its importance: Types of biodiversity - wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services. Drivers of biodiversity loss. Tools and techniques for biodiversity estimation: Biodiversity indices; methods of biodiversity monitoring.

(c) Uses of biodiversity – source of food, medicine, raw material, aesthetic and cultural values.

(d) Threats to biodiversity; natural and anthropogenic, species extinctions, IUCN threat categories, red data book. Extinction: Types, Causes – population growth, overconsumption, pollution, climate change. Ecological extinction, biological extinction.

(e) Principles and strategies for biodiversity conservation - *In-situ* conservation: sanctuaries, biosphere reserves, national parks, nature reserves, preservation plots. *Ex-situ* conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; *In-vitro* Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank. GEF-World Bank initiatives. Biodiversity hotspots and their characteristics, global distribution. National and international programmes for biodiversity conservation. CITES and TRAFFIC, Indian Biodiversity Act 2002 and Rules.

(d) Biological Invasions: Introduction - Elton's hypothesis – Invasion patterns and process - biological attributes for invasion: Reproductive potential, Allelopathy - Phenotypic plasticity - fitness to the new environment. Hypotheses for invasion success: Natural enemy hypothesis - evolution of invasiveness hypothesis, empty niche hypothesis, novel weapon hypothesis, disturbance hypothesis and Propagule pressure hypothesis. Invasive alien species of India (plants and animals).

(e) Impacts and management of invasions: Impacts of exotics on biodiversity, productivity, nutrient cycling. Management: Bio-control programmes, mechanical and chemical control - Positive utilization. Quarantine and EIA of biological invasion.

Module 8: Environmental economics (10 hrs)

(a) Definition, scope and basic theories of environmental economics; sustainable growth.

(b) Economics of natural resources, environment cost-benefit analysis.

(c) Agricultural development and environment: Modern agriculture and its impact on environment – monoculture plantations, use of insecticides, pesticides, chemical fertilizers, hybrid seeds, water consumption, watershed problem, soil erosion, deforestation, desertification, depletion of biodiversity. Sustainable agriculture – alternate methods in agriculture.

(d) Industrial development and environment: impact of modern large scale industries on environment, problems related to modernization and urbanization. Green policies of industrialization.

Module 9: Society and Environment (10 hrs)

(a) Social perspectives of environment – Global and Indian issues.

(b) Social impacts of growing human population and affluence, production and distribution of food, hunger, poverty, malnutrition, famine.

(c) Social impacts of water crisis, global climate change, ozone depletion, nuclear accidents, acid rain, consumerism and waste products.

(d) Problems related to major dams and other developmental projects, resettlement and rehabilitation.

(e) Environment and human health – epidemiological issues.

Module 10: Environmental ethics (4 hrs)

Importance and need of environmental ethics. Moral relation among humans, nonhumans, and natural environment. Position of humans in the world, human responsibility to care the world, animal rights.

Practical (54 hrs)

1. Water Quality Analysis:

a. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica.

b. Determination of total dissolved salts (TDS).

2. Toxicity Analysis of Water: For Chlorine, H2S, Ammonia, Copper and Chromium.

References

1. APHA-AWWA-WPCF (1990). *Standard Methods for the Examination of water and Waste water.* (XX Edn). American Public Health Association.
2. Butter G C (1988). *Principles of Ecotoxicology.* John Wiley and Sons.
3. Cockerham G L, Shane B S (Eds) (1994). *Basic Environmental Toxicology*. CRC Press.
4. Eisenbude M (1998). *Environmental Radioactivity*. Academic Press.
5. Fellenberg G (1999). *Chemistry of Pollution*. John Wiley and Sons.
6. Hayes W A (2001). *Principles and Methods of Toxicology*. CRC Press.
7. James P, Lodge J R (1971). *Methods of Air sampling and Analysis.* ISc Lewis Pub. Inc.
8. Khopkar S M (2004). *Environmental Pollution: Monitoring and Control.* New Age International.
9. Klaassen C D, J B W Alkins (2003). *Essentials of Toxicology*. McGraw-Hill Professional.
10. Lutgens F K, Tarbuek J E (1992). *The Atmosphere*. Prentice Hall.
11. Michael L McKinney, Robert M Schoch (2002). *Environmental science: Systems and Solutions*. West publishing company.
12. Niesink R J M, De Vries J, Hollinger M A (Eds) (1996). *Toxicology: Priniples and Applications.* CRC Press.
13. Odum E P, Barrett G W (2005). *Fundamentals of Ecology*- 5th Edition. Brooks/Cole Publishing Co.
14. Oehme W F (1989). *Toxicity of Heavy Metals in Environment.* Marcel Dakkar Inc.
15. Purnima B B, A Janin, Arun K Jain (2011). *Waste Water Engineering Including Air Pollution*. Laxmi Publications (P) Ltd.
16. Samuel G (1990). *Nuclear Engineering.* Academic Press.
17. Smith T M Smith R L. (2012). *Elements of ecology*, 8th edition, Benjamin Cummins.
18. Wilber C G (1989). *Biological aspects of Water pollution.* Charles C Thomas Publishers.

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY030403: ENVIRONMENTAL MONITORING AND MANAGEMENT
(Theory 90 Hrs; Practical 54 Hrs; Credits 4)

Module 1: Environmental Management (12 hrs)

(a) Concepts, strategies and basic principles of environment management. Management of physical, social, and economic environment. Concepts and scope of environmental planning, regional planning and management. Cost-benefit analysis and Resource economics.
(b) Environmental modeling: Simulation modeling, input-output modeling, Linear programming, Software and resource management.
(c) Tool box for environmental management – An overview of Ecological foot prints, carbon footprints, SEA, Ecological Economics, conflict resolution strategies. Eco-funds.
(d) Environmental auditing and Standards - Eco labeling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental management systems (EMS) - ISO 14000, green auditing.

Module 2: Ecosystem Management (10 hrs)

(a) An overview - Population, Resources and Ecosystem management - Exponential growth in human numbers and the implications.
(b) Major management concepts and methodologies: The five basic laws of Ecology and their relevance for ecosystem management; paradigm shifts in the management of Ecosystems - influence of economics in ecology.
(c) Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas.
(d) Environmental planning and management of; waste lands, reclaimed lands, mining areas, human settlements, industrial lands and agricultural lands.
(e) Eco-restoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management.

Module 3: Solid Waste Management (8 hrs)

Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing, resources recovery and recycling, incineration, pyrolysis, aerobic and anaerobic systems-composting, vermicomposting and sanitary landfills and biodigesters (Biogas). Management of plastic and e-waste. Better management strategies (any two model case studies).

Module 4: Toxicology (15 hrs)

(a) Definition, scope and history of Toxicology, Acute and chronic toxicity, selective toxicity, dose, synergism and antagonism. Teratogenicity, carcinogenicity and mutagenicity
(b) Toxic chemicals in the Environment – Air, water and Soil. Biochemical aspects of As, Cd, Pb, Hg, CO, O_3, PAN, pesticides, MIC, Dioxins, Furans and carcinogens in air, Bioaccumulation & biomagnification.
(c) Occupational Toxicology - hazardous chemicals, disorders exposing from chemical exposure at work, assessment of occupational hazards.

(d) Dose-Response relationships: Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC_{50}; Margin of safety; Toxicity curves; Cumulative toxicity and LD_{50}& CTF.
(e) Toxicity testing: Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC_{50}, Limitation and importance of Bioassay.

Module 5: Environmental Impact Assessment (6 hrs)

(a) Introduction, definition, history, aim, principles, concept and scope. Baseline data collection, Methods and steps – Ad hoc method, checklist method, matrices, Map overlays method, network method, index method.
(b) Impact assessment and impact evaluation: E1A Processes, Stages, E1A Statement. Environment management plan - Environmental Risk Assessment- National Policy on EIA.
(a) Life Cycle Assessment (LCA) and its significance.

Module 6: Remote Sensing and GIS (17 hrs)

(a) Principles and concepts of Remote Sensing. Electromagnetic spectrum; spectral characteristics of surface features (rocks, soils, vegetations, water). Space imaging - Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT. Satellites and their sensors, geometry and radiometry. History and advancement of remote sensing in India, Chandrayaan and MOM,
(b) Digital Image Processing: Principles, Image Rectification and restoration, Image enhancement and Mosaicing. Image classification. Supervised, Unsupervised, Ground truth data
(c) Geographical Information System (GIS): Basic principles and terminologies, Raster and vector data, Topology creation, overlay analysis, Data structure and Digital cartography; Software used in GIS Surveying: Leveling, Triangulation, Geodetic survey; Global Positioning System (GPS) - Basic principles, Applications to environmental studies.

Module 7: Environment versus Development (5 hrs)

(a) Dominance of man on earth. Limits of growth. Industrial revolution and resource utilization, environmental consequences. Modern agriculture and green Revolution - environmental impacts. Conflicts of interest - mega developmental projects and issues of 3 Rs, environment and development.
(b) Disaster management, general principles

Module 8: Sustainable Development (10 hrs)

(a) Principles of sustainability - Reliance on solar energy, biodiversity, population control, Sustainability indicators.
(b) Our Common future and the idea of Sustainable Development - Concepts and dimensions. Basic needs - Imperatives relating to sustainable development. Johannesberg Conference 2002 and follow up Conference on sustainable development. Securing Sustainable futures - Millennium development goals and strategies; the earth charter; need and scope for evolving participatory, community based environmental management strategies. Education for sustainability. Building sustainable societies and lifestyles. Environmental concerns in traditional societies.

Module 9: Environmental laws and policies (7 hrs)

(a) Historical background of environmental law and policy in India.
(b) The salient features of the following acts and rules: The water (Prevention and control of pollution) act, 1974; The air (Prevention and control of pollution) act, 1981; The environmental (Protection) act, 1986; The wildlife protection act, 1972; The forest conservation act, 1980; The biodiversity act, 2002, The noise pollution (Regulation and control) rules, 2000, The Kerala conservation of paddy land and wetland act 2008.

Practical (54 hrs)

1. Estimation of BOD and COD of polluted water.
2. Isolation and Enumeration of microorganisms in soil (TBC or TMC) - Types of Bacteria and fungi.
3. Bacteriological quality testing of water and waste water.

a. Presumptive Coliform test b. Confirmatory Coliform test.

Field Study: (Three/four days) Visit at least one Institution engaged in environment/conservation research and a sanctuary/national park and an industrial/polluted area or any natural ecosystems. Submit a report of the study with photgraphs of the activity.

References

1. Agarwal N K (2004). *Essentials of GPS*. Spatial Networks Pvt. Ltd.
2. Agarwal N K (2002). *Eco-informatics*. APH Publishing Corporation.
3. Asit K Biswas et.al., (1987). *EIA for Developing Countries*. Moduled Nations University, Tokyo.
4. Carter L (1996). *Environmental Impact Assessment*. McGraw Hill.
5. Coronel C, Morris S, Rob P (2009). *Database Systems: Design, Implementation and Management* (IX Edn). Course Technology.
6. Eagles P F J (1987). *The planning and Management of Environmentally Sensitive areas*. Longman Group Ltd.
7. Elachi C (1978). *Introduction to Physics and Techniques of Remote sensing.* John Wiley Pub.
8. Emery W, Camps A (2017). *Introduction to satellite remote sensing*. Elsevier.
9. Floyd F, Sabins W H Jr. (1987). *Remote Sensing, Principles and Interpretation* (II Edn). Freeman & Company.
10. Gadgil M, Guha R (1995). *Ecology and Equity: The Use and Abuse of Nature in Contemporary India*. Penguin India.
11. Gadgil M, Guha R (1998). *The Fissured Land: An Ecological History of India*. Oxford University Press.
12. Goldsmith B (Ed) (1992). *Monitoring for Conservation and Ecology.* Chapman and Hall.
13. Jorgensen S E (1996). *Applications of ecological modeling in environmental management.* Elsevier Sci. Co.
14. Jorgensen S E, Chon T S, Recknage F A (2009). *Handbook of Ecological Model and Informatics.* WIT Press.
15. Kang-tsung C (2000). *Introduction to GIS*. Tata McGraw Hill.
16. Knight R L, White L (2009). *Conservation for a new generation redefining natural resources management.* Island Press.
17. Lawrence D P (2003). *Environmental Impact Assessment: Practical Solutions to Recurrent Problems.* John Wiley and Sons.
18. Lillesand T M, Kiefer R F (1994). *Remote Sensing and Image interpretation*. John Wiley & Sons.

19. Maguire D, Batty M, Goodchild M (Eds.) (2005). *GIS, Spatial Analysis, and Modeling*. Esri Press.
20. Meadows D, Randers J, (2004). *Limits to Growth: The 30 Year Update.* Earthscan.
21. Meffe G K, L Nielson, R Knight, Schenborn (2002). *Ecosystem management: Adaptive, Community-based Conservation*. Plenum Press.
22. Miller G T Jr. (2005). *Advantage Series: Sustaining the Earth: An Integrated Approach*. (VII Edn). Thomson/Brooks Cole.
23. Miller GT Jr. (2004). *Environmental Science*. Thomson, California.
24. Milner-Gulland E J, Marcus Rowcliffe (2007). *Conservation and sustainable use: A handbook of techniques.* Oxford University Press.
25. Peter Calow (Ed) (1998). *Handbook of Environmental Impact Assessment*. Mc Graw Hills Inc.
26. Pullin A S (2002). *Conservation Biology*. Cambridge University Press.
27. Rao D P (Ed) (1998). *Remote Sensing for Earth Resources*. Association of Exploration Geophysicist, Hyderabad.
28. Schowengerdt R (2012). *Remote sensing* 2nd edition, Academic Press.
29. Simon Dresner (2008). *The Principles of Sustainability Solutions*. Earthscan paperbacks, *The Ecological Footprint Atlas 2010*. Oakland: Global Footprint Network.
30. Solimini D (2016). *Understanding earth observation*. Springer.
31. Westman W E (1995). *Ecology, Impact Assessment and Environmental Planning*. John Wiley and sons.
32. World Commission on Environment and Development (1987). '*Our Common Future'.* Oxford University Press.

MODEL QUESTION PAPERS

M Sc Botany Degree (C.S.S) Examination

IV Semester

Faculty of Science

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY820401: BASIC CONCEPTS IN ENVIRONMENTAL STUDIES

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. Define atmosphere
2. Differentiate lentic and lotic ecosystems?
3. Distinguish between weather and climate

4. Define tundra
5. What are Ramsar sites?
6. Define commensalism
7. Describe carrying capacity
8. What are savannas?
9. Define primary production
10. Differentiate mantle and crust

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Define mangroves, differentiate true and back mangals with suitable examples
12. Mention the components of climate system
13. Describe the stratification of marine environment
14. Describe Hadley, Ferrel and Polar cells
15. Describe estuaries with its major types
16. Mention the factors influencing world climatic regions
17. Briefly describe dynamics of community development
18. Describe population interactions

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Describe wetland ecosystems and its functions. Give a special reference to Ramsar sites in India and Kerala
20. Explain global climatic phenomena and effect of climate change on ecosystems
21. Illustrate ecological processes of community formation
22. Describe the classification of climate by Koppen's and Thornthwaite's scheme.

(2 x 5 = 10)

M Sc Botany Degree (C.S.S) Examination

IV Semester

Faculty of Science

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY802402: NATURAL RESOURCES AND THEIR MANAGEMENT

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What are renewable and non-renewable resources
2. What is desalination?
3. Describe major food sources of the world
4. Define reforestation
5. Define biodiversity act of India?
6. Comment on red data book
7. Define biodiversity
8. Expand CITES
9. Define invasive alien species with suitable examples
10. Mention Montreal protocol

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Explain watershed management
12. Mention alternate energy sources
13. Describe the methods of biodiversity monitoring
14. Describe the hottest hotspots of biodiversity and their major characteristics
15. Briefly explain EIA
16. Describe the impact of dams and other developmental projects to the environment
17. Write notes on environmental ethics
18. Define sustainable agriculture

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Describe the principles and strategies for biodiversity conservation
20. Explain biological invasions
21. Illustrate modern agriculture and its impact on environment
22. Describe the processes of nuclear energy, explain the advantages and disadvantages.

(2 x 5 = 10)

M Sc Botany Degree (C.S.S) Examination

IV Semester

Faculty of Science

PROGRAMME ELECTIVE – ENVIRONMENTAL SCIENCE
BY820403: ENVIRONMENTAL MONITORING AND MANAGEMENT
(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is environmental modelling
2. Define ecological foot prints
3. Describe eco-restoration
4. Distinguish between synergism and antagonism.
5. Expand PAN and MIC
6. Define geodetic survey
7. Describe sustainable development
8. What is MOM?
9. Comment on Kerala conservation of paddy land and wetland act 2008.
10. Name two international remote sensing agencies

(8 x 1 = 8)

Section B

(Answer any **six** questions. Each question carries a weight of 2)

11. Define ISO standards and green auditing
12. Mention the general principles of disaster management
13. Describe the five basic laws of ecology
14. Comment on solid waste management
15. Describe bioassays with suitable examples
16. Mention the need of EIA
17. Briefly describe about the environmental impacts of modern agriculture and green revolution
18. Describe briefly on GIS and GPS

(6 x 2 = 12)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Describe environmental management
20. Explain remote sensing and its implications, briefly describe on current satellites of India and their purposes
21. Explain the major environmental laws and policies of India
22. Give an account of solid waste management

(2 x 5 = 10)

SEMESTER IV: ELECTIVE - ENVIRONMENTAL SCIENCE
BY802404: PRACTICAL COURSE I
BASIC CONCEPTS IN ENVIRONMENTAL STUDIES

Time: 4 hours **Weightage: 30**

1. Find out the abundance, frequency, density and the relative density of the species from the given data A on the two quadrats selected for study. Determine the similarity index of two quadrats.(Total weight 4: Abundance – 1; Frequency –1; Density – 1; Similarity index – 1)
2. Determine the biomass of the phytoplankton of the given sample B using haemocytometer. (Total weight 4: working 2; Calculation 2)
3. Determine the pH of the given polluted soil sample C and identify the type of soil. (Total weight 2: Determination of pH 1; Identification of soil type 1)
4. Determine the chloride/calcium/magnesium hardness of the given sample D. (Total weight 6: Working – 2; Procedure – 2; Result and Comments – 2)

5. Determine the Dissolved oxygen content of the given sample E and determine the primary productivity using light & dark bottle method.
   (Total weight 6: Working – 2; Procedure – 2; Result and Comments – 2)
6. Comment on the materials F, G, H and I.
   Weight 1: 1 x 4 = 4)
7. Practical record
   (Weight 4)

Key to the questions:
1. A - Provide necessary data
2. B - Give appropriate sample
3. C - Give necessary soil sample
4. D - Give appropriate samples
5. E - Give appropriate sample
6. F, G, H, I – plant materials with ecological peculiarities
7. Awarding 'A grade' to the record of practical work shall be considered only if all the practicals specified in the syllabus are completely done and recorded properly. This also includes field study report(s)/Lab visit report(s), if any.

ELECTIVE – ENVIRONMENTAL SCIENCE
BY802405: PRACTICAL COURSE II
NATURAL RESOURCES AND THEIR MANAGEMENT, ENVIRONMENTAL MONITORING AND MANAGEMENT

Time: 4 hours **Weightage: 30**

1. Determine the BOD of the water sample A.
   (Total weight 6: Principle and procedure – 2; Working – 2; Calculation -1; Result – 1)

2. Estimate the Alkalinity / salinity/ Total hardness of the given sample B.
   (Total weight 5: Working – 2; Calculation 1; Interpretation/Comments – 2)

3. (a) Determine the TDS of the given sample C
   (Total weight 5: Procedure 2; Working 2; Results and comments - 1).

or

3. (b) Toxicity analysis of water. Determine amount of chloride or ammonia present in the given polluted water sample C.
   (Total weight 5: Working –2; Procedure – 2; Result and comments- 1)

4. Examine the bacteriological quality of water sample D by performing presumptive coliform test and analyze the data by MPN index table.
   (Total weight 6: Principle and procedure – 2; Working – 1; Data analysis and interpretation – 3)

5. Illustrate the environmental consequence/ significance of the published pictures E and F.
   (Weight 4:2 x 2 = 4)

6. Practical record
   (Weight 4)

Key to the questions:

1. A - Incubate the sample for 5 days before the exam. First day oxygen data can be provided. Titration to find out the final value only is done at the time of exam.
2. B – Give appropriate samples
3. C – (a) TDS determination by Flurometer (b) Give appropriate samples
4. D - Day before the exam, inoculate the MPN tubes with appropriate water sample
5. E, F - Published diagram/photograph from popular journals/periodicals/dailies
6. Awarding 'A grade' to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely and recorded properly. This also includes field study report(s)/Lab visit report(s), if any.