Year 4th B.Sc. (Hons.)/B.Sc. (Hons. with Research)/M.Sc.
Botany Curriculum

Maharaja Suhel Dev State University Azamgarh

Year 4th B.Sc. (Hons.)/M.Sc., Semester First			
Paper Code	**Title of the Paper/Course**	**Category of Paper/Course**	**Credits**
B040701T	Microbiology	Compulsory	4
B040702T	Phycology and Bryophytes	Compulsory	4
B040703T	Pteridophytes and Gymnosperms	Compulsory	4
B040704T	Cell Biology	Elective	4
B040705T	Mycology	Elective	4
	Practical	Compulsory	4
Semester Credits			**20**
One Elective Paper has to be taken other than compulsory Papers			

Year 4th B.Sc. (Hons. With Research), Semester First			
Paper Code	**Title of the Paper/Course**	**Category of Paper/Course**	**Credits**
B040701T	Microbiology	Compulsory	4
B040702T	Phycology and Bryophytes	Compulsory	4
B040703T	Pteridophytes and Gymnosperms	Compulsory	4
	Major Research Project	Compulsory	4
	Practical	Compulsory	4
Semester Credits			**20**

16.10.2024

Dr. Abdullah (Convener) | Prof. Anil Kumar Dwivedi (External Expert) | Dr. M. Zeeshan Beg (External Expert) | Prof. M. Jaish Beg (P.G. Member)

Dr. M. Ahsan Beg (P.G. Member) | Shri Rajnish Bharati (U.G. Member) | Shri Amit Kumar Patel (U.G. Member)

Year 4th B.Sc. (Hons.)/M.Sc., Semester Second			
Paper Code	**Title of the Paper/Course**	**Category of Paper/Course**	**Credits**
B040801T	Plant Anatomy and Developmental Biology	Compulsory	4
B040802T	Taxonomy of Angiosperms	Compulsory	4
B040803T	Plant Pathology	Compulsory	4
B040804T	Genetics and Genomics	Elective	4
B040805T	Palaeobotany and Palynology	Elective	4
	Practical	Compulsory	4
Semester Credits			**20**
One Elective Paper has to be taken other than compulsory Papers			

Year 4th B.Sc. (Hons. With Research), Semester Second			
Paper Code	**Title of the Paper/Course**	**Category of Paper/Course**	**Credits**
B040801T	Plant Anatomy and Developmental Biology	Compulsory	4
B040802T	Taxonomy of Angiosperms	Compulsory	4
B040803T	Plant Pathology	Compulsory	4
	Major Research Project	Compulsory	4
	Practical	Compulsory	4
Semester Credits			**20**

16.10.2024

16/10/24

M.Sc., Semester Third			
Paper Code	**Title of the Paper/Course**	**Category of Paper/Course**	**Credits**
B040901T	Plant Physiology and Biochemistry	Compulsory	4
B040902T	Plant Biotechnology and Molecular Biology	Compulsory	4
B040903T	Plant Resource Utilization and Conservation	Elective	4
B040904T	Soil Science and Phytogeography	Elective	4
	Major Research Project	Compulsory	4
	Practical	Compulsory	4
Semester Credits			**20**
One Elective Paper has to be taken other than compulsory Papers			

M.Sc., Semester Fourth				
Paper Code		**Title of the Paper/Course**	**Category of Paper/Course**	**Credits**
Group I	B0401001T	Plant Ecology	Elective	4
	B0401002T	Water Resource Management	Elective	4
Group II	B0401003T	Cytogenetics, Plant Breeding and Biostatistics	Elective	4
	B0401004T	Forest Ecology	Elective	4
Group III	B0401005T	Computer Application and Bioinformatics	Elective	4
	B0401006T	Environmental Management and Technology	Elective	4
		Major Research Project	Compulsory	4
		Practical	Compulsory	4
Semester Credits				**20**
One Paper from Each Group of Elective Papers has to be taken				

Note: Practical Examinations and Major Research Project Evaluation has to be conducted by External Examiners.

Year 4th B.Sc. (Hons.)/M.Sc., Semester First

Paper I, Microbiology **Credits 4**

Unit-I

Basis of bacterial classification, Bacterial isolation, Serial dilution and enrichment culture techniques. Maintenance and preservation of Bacterial culture.

Unit-II

Genetic analysis of Bacteria; conjugation, transformation and transduction lytic and lysogenic, Transposons, Nitrogen metabolism; ammonification, nitrogen fixation nitrification and denitrification. Commercial use of bacteria

Unit-III

Classification of plant viruses, characteristics and ultrastructure of viruses; Isolation, purification and characterization of Viruses. Chemical nature, replication, transmission of viruses, economic importance

Unit-IV

General symptoms of viral infection, Phytoplasma General characteristics and its role in causing plant disease

Suggested Readings:

1. Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA (2014) Brock Biology of Microorganisms, 14 th edition, Benjamin Cummings, New York.
2. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1987) General Microbiology, 5th edition, MacMillan, Press Ltd, New Jersey.
3. Talaro KP, Chess B (2011) Foundations in Microbiology, 8th edition, McGraw-Hill, New York.
4. Willey JM, Sherwood L, Woolverton CJ (2013) Prescott's Microbiology, 9th edition, McGraw-Hill, New York.
5. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Practicals:

1. Introduction to basic microbiological techniques and lab safety.
2. Methods of sterilization, media preparation and culturing.
3. Staining of Gram + ve and Gram - ve Bacteria. Isolation and identification of bacteria from sewage, soil, decaying fruits and vegetables.

Amit 16/10/24

Paper II, Phycology and Bryophytes — Credits 4

Unit–I

Principles and important systems of algal classification. Life cycle patterns, Algal Culture, Economic and environmental aspect of algae. Algal bloom, algal toxins and fisheries.

Unit- II

General characters, occurrence, habitat, Cellular Organization, reserve food material and reproduction in the following classes.

- Cyanophyceae; *Gleoetrichia, Oscillatoria, Nostoc* and *Scytonema*
- Chlorophyceae; *Chlorella, Hydrodictyon, Cladophora, Oedogonium* and *Chara.*
- Phaeophyceae; *Ectocarpus, Dictyota* and *Laminaria.*
- Rhodophyceae; *Batrachospermum, Polysiphonia* and *Gelidium.*
- Xanthophyceae; *Botrydium* and *Vaucheria*
- Bacillariophyceae; *Navicula.*

Unit–III

Bryophytes: Origin and evolution of sporophytes, Classification, Geographical distribution, economic importance of bryophytes

Unit-IV

Comparative study of Morphology anatomy life history, Classification and phylogeney of Hepaticopsida;

Marchantia, Pellia, Porella, Plagiochasma and *Takakia, Anthocerotopsida; Anthoceros and Notothylus* and,

Bryopsida; *Sphagnum Funaria, Polytrichum,* Fossil Bryophytes.

Suggested Readings

1. Puri P (1980). Bryophytes. Atma Ram & Sons, New Delhi.
2. Kumar HD (1988). Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
3. Morris J (1986). An Introduction to the Algae. Cambridge University Press, U.K.
4. Round FE (1986) The Biology of Algae. Cambridge University Press, U.K.

Practicals;

1. Identification of the genera mentioned in Cynophyceae, Chlorophyceae, Bacillariophyceae, Xanthophyceae, Phaeophyceae and Rhodophyceae.
2. Identification of bloom forming algae.
3. Identification of Algal biofertilizers and toxic algae.
4. Morphologiocal and anatomical structure of Bryophytes genera mentioned in class Hepaticopsida. Anthocerotopsida and Bryopsida.
5. Study of Sporophytes of the following genera.

Anthoceros, Funaria and Marchantia.

Paper III, Pteridophytes and Gymnosperms — Credits 4

Unit-I

Classification and origin of Pteridophytes; Vegetative sporophytes; stellar theory: Telome theory, ontogeny. Heterospory and Seed habit: Occurrence, cause and significance. Apospory and Apogamy.

Unit-II

The gametophytes: Germination of fern spores, development of fern prothallus; Comparative study of Psilophyta; (*Psilotum*), Lycopsida; (*Lycopodium*) and (*Selaginella*), Sphenopsida; (*Equisetum*), and Pteropsida; (*Nephrolepis*) and (*Marsilea*).

Unit-III

Classification of Gymnosperms up to the rank of orders. General account of the Fossils of Medullosaceae (Medullosa), Pentoxylales (Pentoxylon), Corditales (Cordaites sp.)

Unit-IV

General account of the following groups with special reference to the genera indicated in brackets: Gingoales (*Ginkgo biloba*), general anatomy, cone organization, life history and distribution, Ephedrales(*Ephedra* sp.) Gnetales (*Gnetum* sp.) and Welwitschiales (*Welwitschia* sp.)

Suggested Readings:

1. Bhatnagar SP, Moitra A (1996) Gymnosperms, New Age international Ltd Publication, New Delhi.
2. Parihar NS (1973) An Introduction to Embryophyta, Vol I (Bryophyta) and Vol II(Pteridophyta), Central Book Department, Allahabad.
3. Parihar NS (1996). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
4. Rashid A (2011) An Introduction to Pteridophyta, 2nd edition, Vikas Publishing House Pvt. Ltd, Noida.
5. Sambamurty AVSS (2005) A Textbook of Bryophytes, Pteridophyte
6. Sporne KR (1965). The Morphology of Gymnosperms. Hutchinson Univ. Library
7. Sporne KR (1967) Morphology of Gymnosperms. BI Publication, New Delhi.
8. Sporne KR 1991. The Morphology of Pteridophytes. BI Publication, New Delhi.

Practicals:

1. Morphology and anatomy of vegetative and reproductive organs of following genera- *Psilotum, Isoetes, Dryopteris, Ophioglossum, Adiantum, Salvinia, Azolla* and *Lycopodium.*
2. Comparative study of vegetative, reproductive and anatomy of the following genera- *Genetum, Cedrus, Ephedra, Thuja, Ginkgo* and *Taxus.*

Paper IV-A, Cell Biology — Credits 4

Unit I

Structure and functions of cell organelles: Plasma membrane and models; Cell wall; Nucleus: Nuclear pore complex; Cytosol: chemical composition, Mitochondria; Chloroplast and other important plastids; Golgi bodies; Endoplasmic reticulum; Vacuoles; Lysosomes; Peroxisomes.

Unit II

Cell division: Mitosis and Meiosis, Regulation of Cell division, Spindle organization and chromosomal movement; Cell Cycle: Steps and its regulation, Cell cycle checkpoints; Uncontrolled Cell division: Tumor and Cancer formation; Apoptosis and programmed cell death in plants.

Unit III

Cytoskeleton: Microtubules, Intermediate and microfilaments; Cell junctions: Major Types (Anchoring, Tight, Gap and Plasmodesmata) and its function.

Unit IV

Cell signaling: Overview of receptors, Secondary Messengers; G- protein and GPCRs (G-Protein Coupled Receptors); Calcium- calmodulin cascade; Receptor tyrosine kinases (RTKs).

Suggested Readings:

1. Brown WV & Berke MB (1974). Textbook of Cytology, Blackstains Sons & Co.
2. Brachet J & Mirsky AE (1959). The Cell, Academic Press, Vols. 16D
3. De Robertis EDP & De Robertis EMF 8. (2001). Cell and Molecular Biology, Lippineott Williams & Wilkins, Bombay.
4. Wolfe SL (1993). Molecular and Cellular Biology, Wordsworth Publ. Co., California, USA.
5. Sharma AK & Sharma A (1980). Chromosome Techniques. Theory and Practice, Butterworth.
6. Roy SC & Kumar KDC (1977). Cell Biology, New Central Book Agency, Calcutta.
7. Lodish, Harvey F. (2000). Molecular Cell Biology.
8. Nelson, David L. (David Lee), 1942- (2005). Lehninger. Principles of Biochemistry

Practicals;

1. Cytological Squash preparation of onion and garlic root tips to study mitosis.
2. Identify the stages of meiosis in squash preparation of onion and *Phlox* floral buds and barley anther.

Paper IV-B, Mycology

Credits 4

Unit-I

Outline classification as per Smith Ainsworth, Mims, Comparative account of Thallus structure and spore producing organs.

Unit-II

Interrelation life cycle pattern & Phylogeny of Myxomycotina, Zygomycotina, Ascomoycotina, Basidiomycotina and Deuteromycotina.

Unit-III

Mode of nutrition of fungi and their physical and chemical requirement for growth and reproduction.

Unit-IV

Heterokaryosis, parasexuality, heterothallism, variation in fungi, hormonal control of sexual reproduction. Economic importance of fungi rement for growth and reproduction.

Suggested Readings:

1. Alexopoulos CJ, Minus CW, Blackwell M (1996) Introductory Mycology, John Cambridge.
2. Carlile MJ, Watkinson SC, Booday GW (2001) The Fungi, Academic Press,
3. Deacon JW, Blackwell M (1997) Introduction to Modern Mycology, Oxford.
4. Maheshwari R (2012) Fungi: Experimental Methods in Biology, CRC Press, Boca Raton, Florida.
5. Webster J, Roland WS (2007) Introduction to Fungi, Cambridge University Press,
6. Webster John (1980) Introduction to fungi, Cambridge University Press, Wiley and Sons, Inc, New York. Alexopoulos CJ, Minus CW, Blackwell M (1996) Introductory Mycology, John Cambridge.
7. Webster John (1980) Introduction to fungi, Cambridge University Press, Wiley and Sons, Inc, New York.

Practicals;

1. Identification of fungal cultures
2. Slides and specimens of *Synchytrium, Allomyces, Glomus, Emericella, Neurospora, Morchella, Fusarium, Colletotrichum, Melampsora, Phallus, Ustilago, Peronospora, and Stemonitis.*
3. Study of Symptomology of the following fungal diseases by taking sections and slide preparation: Downy mildews, Tikka disease, *Melampsora* rust, Wheat rust and White rust.
4. Identification of fungal cultures, slides and specimens of *Rhizopus, Aspergillus, Penicillium, Yeast, Fusarium, Alternaria, Cercospora, and Pythium,*
5. VAM fungi, *Trichoderma.* Study of Mycorrhizal colonization in roots of *Parthenium* and Study of Mushroom specimens.

Year 4th B.Sc. (Hons. With Research), Semester First

Paper I, Microbiology **Credits 4**

Unit-I

Basis of bacterial classification, Bacterial isolation, Serial dilution and enrichment culture techniques. Maintenance and preservation of Bacterial culture.

Unit-II

Genetic analysis of Bacteria; conjugation, transformation and transduction: Lytic and Lysogenic, Transposons. Nitrogen metabolism; ammonification, nitrogen fixation nitrification and denitrification, Role of microbes in nitrogen cycle. Commercial use of bacteria

Unit-III

Classification of plant viruses, characteristics and ultrastructure of viruses; Isolation, purification and characterization of Viruses. Chemical nature, replication, transmission of viruses, economic importance

Unit-IV

General symptoms of viral infection, Phytoplasma General characteristics and its role in causing plant disease

Suggested Readings:

1. Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA (2014) Brock Biology of Microorganisms, 14 th edition, Benjamin Cummings, New York.
2. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1987) General Microbiology, 5th edition, MacMillan, Press Ltd, New Jersey.
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5. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Practicals:

1. Introduction to basic microbiological techniques and lab safety.
2. Methods of sterilization, media preparation and culturing.
3. Staining of Gram + ve and Gram - ve Bacteria. Isolation and identification of bacteria from sewage, soil, decaying fruits and vegetables.

16/10/24

Paper II, Phycology and Bryophytes — Credits 4

Unit–I

Principles and important systems of algal classification. Life cycle patterns, Algal Culture, Economic and environmental aspect of algae. Algal bloom, algal toxins and fisheries.

Unit- II

General characters, occurrence, habitat, Cellular Organization, reserve food material and reproduction in the following classes.

- Cyanophyceae; *Gleoetrichia, Oscillatoria, Nostoc* and *Scytonema*
- Chlorophyceae; *Chlorella, Hydrodictyon, Cladophora, Oedogonium* and *Chara.*
- Phaeophyceae; *Ectocarpus, Dictyota* and *Laminaria.*
- Rhodophyceae; *Batrachospermum, Polysiphonia* and *Gelidium.*
- Xanthophyceae; *Botrydium* and *Vaucheria*
- Bacillariophyceae; *Navicula.*

Unit–III

Bryophytes: Origin and evolution of sporophytes, Classification, Geographical distribution, economic importance of bryophytes

Unit-IV

Comparative study of Morphology anatomy life history, Classification and phylogeney of Hepaticopsida;
Marchantia, Pellia, Porella, Plagiochasma and *Takakia, Anthocerotopsida; Anthoceros and Notothylus* and,
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Suggested Readings

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3. Morris J (1986). An Introduction to the Algae. Cambridge University Press, U.K.
4. Round FE (1986) The Biology of Algae. Cambridge University Press, U.K.

Practicals;

1. Identification of the genera mentioned in Cynophyceae, Chlorophyceae, Bacillariophyceae, Xanthophyceae, Phaeophyceae and Rhodophyceae.
2. Identification of bloom forming algae.
3. Identification of Algal biofertilizers and toxic algae.
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5. Study of Sporophytes of the following genera.
   Anthoceros, Funaria and Marchantia.

Paper III, Pteridophytes and Gymnosperms — Credits 4

Unit-I

Classification and origin of Pteridophytes; Vegetative sporophytes; stellar theory: Telome theory, ontogeny. Heterospory and Seed habit: Occurrence, cause and significance. Apospory and Apogamy.

Unit-II

The gametophytes: Germination of fern spores, development of fern prothallus; Comparative study of Psilophyta; (*Psilotum*), Lycopsida; (*Lycopodium*) and (*Selaginella*), Sphenopsida; (*Equisetum*), and Pteropsida; (*Nephrolepis*) and (*Marsilea*). Apospory and Apogamy.

Unit-III

Classification of Gymnosperms up to the rank of orders. General account of the Fossils of Medullosaceae (Medullosa), Pentoxylales (Pentoxylon), Corditales (Cordaites sp.)

Unit-IV

General account of the following groups with special reference to the genera indicated in brackets: Gingoales (*Ginkgo biloba*), general anatomy, cone organization, life history and distribution, Ephedrales(*Ephedra* sp.) Gnetales (*Gnetum* sp.) and Welwitschiales (*Welwitschia* sp.)

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2. Parihar NS (1973) An Introduction to Embryophyta, Vol I (Bryophyta) and Vol II(Pteridophyta), Central Book Department, Allahabad.
3. Parihar NS (1996). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
4. Rashid A (2011) An Introduction to Pteridophyta, 2 nd edition, Pub Vikas Publishing House Pvt Ltd, Noida.
5. Sambamurty AVSS (2005) A Textbook of Bryophytes, Pteridophyte
6. Sporne KR (1965). The Morphology of Gymnosperms. Hutchinson Univ. Library
7. Sporne KR (1967) Morphology of Gymnosperms. BI Publication, New Delhi.
8. Sporne KR 1991. The Morphology of Pteridophytes. BI Publication, New Delhi.

Practicals:

1. Morphology and anatomy of vegetative and reproductive organs of following genera- *Psilotum, Isoetes, Dryopteris, Ophioglossum, Adiantum, Salvinia, Azolla* and *Lycopodium.*
2. Comparative study of vegetative, reproductive and anatomy of the following genera- *Genetum, Cedrus, Ephedra, Thuja, Ginkgo* and *Taxus.*

Year 4th B.Sc. (Hons.)/M.Sc., Semester Second

Paper I, Plant Anatomy and Developmental Biology — Credits 4

Unit-I

The cambium, vascular and cork cambium its derivative tissues, differentiation of secondary phloem and Xylem. Structure of woods in relation to its weight, strength, durability and taxonomic significance. Anomalous secondary growth in roots and stems (monocots & dicots).

Unit-II

Cork cambium and its derivatives, function of cork and its uses, abscission layers. Origin of Lateral and adventitious roots, root-stem transition. Anatomy in relation to taxonomy & embryology.

Unit-III

Male Gametophyte- Microsporogenesis, tapetum and its role, pollen development. Female Gametophyte- Ovule development, Megasporogenesis. Organization of embryo sac, types of embryo sacs. Pollination- Mechanism and vectors`, pollen germination and pollen tube growth.

Unit-IV

Fertilization and its control with special reference to incompatibility in flowering plant. Endosperms & its abnormalities, Embryo developments. Apomixes Polyembryony and its induction.

Suggested Readings:

1. Bhojwani S. S. & Bhatnagar SP (2000). Embryology of Angiosperms (4th Revised and enlarged edition).
2. Burgess J (1985). An Introduction to Plant Cell Development, Cambridge University Press, Oxford.
3. Esau, K. (1993). Plant Anatomy, Wiley Eastern Ltd.
4. Fahn A (1982). Plant Anatomy 3rd Ed, Pergamon Press, Oxford.
5. Integrated plant anatomy by William C, Dickisons 2000
6. Larson PR (1995). The Vascular Cambium, Springer Verlag, Heidelberg, Germany.
7. lqbal M (1990). The Vascular Cambium, R.S.P., Taunton, UK.
8. lqbal M (1995). The Cambial Derivatives, Gebruder Borntraeger, Stuttgart, Germany.
9. Mahswari P (1950). An Introduction to Embryology of Angiosperms. Surjeet Publication, New Delhi

Practicals:

1. Anatomical study of anamolous behavior of the following stems

   Dracaena, Boerhaavia, Nyctanthes, Achyranthus, Bignonia, Casuarina and Bougainvillea.

2. Study of special feature of the following roots, Orchid, Aerial Root of Ficus and Tinospora.
3. Study of the leaf of Nerium, Ficus and Aloe.
4. Study of monocot and dicot embryo.
5. Isolation of pollinium.
6. Elementary techniques of pollen germination

Paper II, Taxonomy of Angiosperms — Credits 4

Unit-I

System of classification, History, outline of basic importance and demerits of following classifications.

- Bentham and Hooker
- Hutchinson
- Engler and Prantl

History and development of APG.

Unit-II

Rules of Botanical Nomenclature, ICBN, Fields and Herbarium techniques, Plants Identification, Taxonomic key, Typification, introduction to taxonomic evidences from cytology, photochemistry, molecular biology data.

Unit-III

General knowledge of distinguishing features of the following families with special reference of best flora,
Dicotyledons: Ranunculaceae, Magnoliaceae, Caryophyllaceae. Asteraceae, Rosaceae, Rutaceae, Anacardiaceae, Fabaceae and Myrtaceae.

Unit-IV

Numerical Taxonomy in relation to Embryology Cytology and Anatomy, Chemotaxonomy. Identification and economic use of following families; Dicotyledons: Oleaceae, Asclepiadaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Acanthaceae, Verbenaceae, Lamiaceae, Polygonaceae,

Piperaceae, Euphorbiaceae and Moraceae.
Monocotyledons: Orchidaceae, Araceacea, Zingiberaceae. Cyperaceae and Poaceae

Suggested Readings:

1. Lawrence, B.M. Taxonomy of vascular plants, IBH publication Tata Mc Grew Hill.
2. Sharma, Trivedi B.S. Taxonomy, Kitab Mahal Prayagraj.
3. Naik, V.N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.
4. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, New York.
5. Singh, Gurcharan (2007). Plant Systematics. Oxford & 1BH Publishing Co, New Delhi.

Practicals:

1. Students have to collect and submit at-least 100 plants properly pressed and mounted on herbarium sheet
2. Identification of angiospermic plants up to the level of family
3. Description of local plant in semi technique language

Paper III, Plant Pathology — Credits 4

Unit-I

Importance and concept of disease in plants, variability in plant pathogen, Mechanism by attack plant pathogen, effect of environment on disease development, plant disease forecasting. Koch's postulates, disease symptoms, pathogen & disease triangle.

Unit-II

Transmission of plant diseases. Isolation and purification plant pathogens, Principle and method of plant disease control.

Unit-III

Rot diseases with special reference to fruit and stem end rot of papaya. Damping off of seedlings of crop plants. Downy mildews of cucurbits. Rust of wheat. Powdery mildew of pea. Smuts and Bunts: Covered smut of Barley; loose smut of wheat and Bunt of rice. Wilt of sugarcane. Leaf spots: leaf spot of turmeric. Blast disease of rice. Galls and other abnormalities: stem gall of coriander leaf curl of Peach.

Unit-IV

Plant disease: Causal organism, symptoms and management

- Bacterial diseases: Citrus canker and Tundu disease of wheat.
- Viral diseases: Mosaics of tobacco, YVM of Okra, Leaf curl of papaya, and tungro of rice.
- Phytoplasmal diseases: Grassy shoot of sugarcane.

Suggested Readings

1. Agrios GN (2005) Plant Pathology, Academic Press, Burlington.
2. John AL (1998) Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press, Publication, Boca Raton, USA.
3. Dickinson CM (2003) Molecular Plant Pathology, Bios Scientific Publisher, Oxford.
4. Bridge PD, Clarkson JM (1998) Molecular Variability of Fungal Pathogens, CAB, International, Oxford shire.
5. Singh RS (2008) Plant Diseases, Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
6. Singh RS (2008) Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt. Ltd, New Delhi.
7. Dhingra OD, James B, Sinclair (1995) Basic Plant Pathology Methods, CRC

Practical:

1. Isolation of bacterial and fungal plant pathogens of crop plants.
2. Study of mineral deficiency diseases of Tomato and French bean.
3. Measurement of fungal spore.
4. Preparation of culture media and sterilization.
5. A study of symptomology, histopathology and identification of pathogen of various fungal diseases listed above.
6. Inoculation experiment with fungal and bacterial plant pathogen.
7. Field collection of 50 diseases plant specimen (fungal, viral and bacterial)
8. Study of Fungal bio-control agents

Paper IV-A Genetics and Genomics — Credits 4

Unit-I

Mendelism and Basic Principle of Heredity. Genetic Terminologies and their concept. Mendel Laws of inheritance: Dominance, Monohybrid cross, Dihybrid cross and Trihybrid cross (Forked-line Method or Branch Diagram Method) with their probability, Law of Segregation, Law of Independent assortment, Test cross, Backcross and Chi-square Test

Unit-II

Incomplete Dominance, Co-dominance, Multiple alleles, Pseudodominance, Over Dominance, Gene Interaction, Epistasis, Pleiotropy, Genomic Imprinting, Penetrance and Expressivity, Linkage and Recombination, Sex linked, influence Character, Inbreeding and outbreeding, heterosis and inbreeding depression.

Unit-III

Morphology and type of chromosome Chromosomal Basis of Mendelism: Chromosome, Chromosome theory of Heredity, Sex linked Gene in Human, Sex determination in Human, Birds, Insect and other organism, Dosage compensation,

Unit-IV

Sex linked and sex influenced characters, introduction and overview: Structural Genomics: Genetic and Physical Map, Entire Genome sequencing, Copy number variations and Single Nucleotide Polymorphism, Meta-genomics and Synthetic Biology

Suggested Readings:

1. Strickburger M (1990). Genetics. MacMillan Publishing Company, New York.
2. Gardner J (1991). Principle of Genetics. John Wiley & Sons, New York.
3. Klug WS& Cummings MR (1997). Essential of Genetics. Prentice Hall Publishing Co., New Jersy.
4. Brown T (1989). Genetics: A Molecular Approach. Chapman & Hall, London.
5. Goodenough U (1984). Genetics. Sandir College Publishing, Philadelphia.
6. Lewin, B. (2007). Genes Vol. 9. Oxford University Press.

Practicals

1. Emasculation techniques.
2. Isolation of protoplast.
3. DNA extraction by centrifugation.
4. Chromosome mapping in eukaryotes.
5. Population Genetics. Problems in Restriction mapping of plasmids

Paper IV-B, Palaeobotany and Palynology — Credits 4

Unit-I

Fossils history of Bryophytes, Pteridophytes and Gymnosperms. Principles of Palaeobotany and Geological time scale.

Unit-II

Process of fossilization and types of fossils; Methods of study of fossils and carbon dating techniques.

Unit-III

Pollen morphology, germ pore, caulpate condition in monocots and dicots.

Unit-IV

Aeropalynology, forensic palaenology and palaeopalynology. Role of palynology in taxonomic evidence, pollen allergy.

Suggested Readings:

1. Stewart Wilson N, Palaenology and evolution of Plants
2. S. R. Mehta, Text Book of Palaenology
3. Peter George, Introduction to Palaenology
4. G Erdtman, Handbook of Palaenology, Moerphology, Taxonomy. Ecology; An Introduction to study of Pollen grains and spores.
5. K. Bhattacharya, M.R. Majumdar and S.G. Bhattacharya, A Textbook of Palynology
6. P.K.K. Nair, Essential of Palaenology

Prcticals:

1. Study of different types of fossils record.
2. Study of the pollen grains of *Cyperus, Canna,* Barley, *Hibiscus, Jatropha* and *Bougainvillea.*

Year 4th B.Sc. (Hons. With Research), Semester Second

Paper I, Plant Anatomy and Developmental Biology **Credits 4**

The cambium, vascular and cork cambium its derivative tissues, differentiation of secondary phloem and Xylem. Structure of woods in relation to its weight, strength, durability and taxonomic significance. Anomalous secondary growth in roots and stems (monocots & dicots).

Unit-II

Cork cambium and its derivatives, function of cork and its uses, abscission layers. Origin of Lateral and adventitious roots, root-stem transition. Anatomy in relation to taxonomy & embryology.

Unit-III

Male Gametophyte- Microsporogenesis, tapetum and its role, pollen development. Female Gametophyte- Ovule development, Megasporogenesis. Organization of embryo sac, types of embryo sacs. Pollination- Mechanism and vectors`, pollen germination and pollen tube growth.

Unit-IV

Fertilization and its control with special reference to incompatibility in flowering plant. Endosperms & its abnormalities, Embryo developments. Apomixes Polyembryony and its induction.

Suggested Readings:

1. Bhojwani S. S. & Bhatnagar SP (2000). Embryology of Angiosperms (4th Revised and enlarged edition).
2. Burgess J (1985). An Introduction to Plant Cell Development, Cambridge University Press, Oxford.
3. Esau, K. (1993). Plant Anatomy, Wiley Eastern Ltd.
4. Fahn A (1982). Plant Anatomy 3rd Ed, Pergamon Press, Oxford.
5. Integrated plant anatomy by William C, Dickisons 2000
6. Larson PR (1995). The Vascular Cambium, Springer Verlag, Heidelberg, Germany.
7. Iqbal M (1990). The Vascular Cambium, R.S.P., Taunton, UK.
8. Iqbal M (1995). The Cambial Derivatives, Gebruder Borntraeger, Stuttgart, Germany.
9. Mahswari P (1950). An Introduction to Embryology of Angiosperms. Surjeet Publication, New Delhi

Practicals:

1. Anatomical study of anamolous behavior of the following stems

   Dracaena, Boerhaavia, Nyctanthes, Achyranthus, Bignonia, Casuarina and Bougainvillea.

2. Study of special feature of the following roots, Orchid, Aerial Root of Ficus and Tinospora.

3. Study of the leaf of Nerium, Ficus and Aloe.
4. Study of monocot and dicot embryo.
5. Isolation of pollinium.
6. Elementary techniques of pollen germination

Paper II, Taxonomy of Angiosperms — Credits 4

Unit-I

System of classification, History, outline of basic importance and demerits of following classifications.

- Bentham and Hooker
- Hutchinson
- Engler and Prantl

History and development of APG.

Unit-II

Rules of Botanical Nomenclature, ICBN, Fields and Herbarium techniques, Plants Identification, Taxonomic key, Typification, introduction to taxonomic evidences from cytology, photochemistry, molecular biology data.

Unit-III

General knowledge of distinguishing features of the following families with special reference of best flora

Dicotyledons: Ranunculaceae, Magnoliaceae, Caryophyllaceae. Asteraceae, Rosaceae, Rutaceae, Anacardiaceae, Fabaceae and Myrtaceae.

Unit-IV

Numerical Taxonomy in relation to Embryology Cytology and Anatomy, Chemotaxonomy. Identification and economic use of following families;

Dicotyledons: Oleaceae, Asclepiadaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Pedaliaceae, Acanthaceae, Verbenaceae, Lamiaceae, Polygonaceae, Piperaceae, Euphorbiaceae and Moraceae.

Monocotyledons: Orchidaceae, Araceacea, Zingiberaceae. Cyperaceae and Poaceae

Suggested Readings:

1. Lawrence, B.M. Taxonomy of vascular plants, IBH publication Tata Mc Grew Hill.
2. Sharma, Trivedi B.S. Taxonomy, Kitab Mahal Prayagraj.
3. Naik, V.N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.

4. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, New York.
5. Singh, Gurcharan (2007). Plant Systematics. Oxford & 1BH Publishing Co, New Delhi.

Practicals:

1. Students have to collect and submit at-least 100 plants properly pressed and mounted on herbarium sheet
2. Identification of angiospermic plants up to the level of family
3. Description of local plant in semi technique language

Paper III, Plant Pathology — Credits 4

Unit-I

Importance and concept of disease in plants, variability in plant pathogen, Mechanism by attack plant pathogen, effect of environment on disease development, plant disease forecasting. Koch's postulates, disease symptoms, pathogen & disease triangle.

Unit-II

Transmission of plant diseases. Isolation and purification plant pathogens, Principle and method of plant disease control.

Unit-III

Rot diseases with special reference to fruit and stem end rot of papaya. Damping off of seedlings of crop plants. Downy mildews of cucurbits. Rust of wheat. Powdery mildew of pea. Smuts and Bunts: Covered smut of Barley; loose smut of wheat and Bunt of rice. Wilt of sugarcane. Leaf spots: leaf spot of turmeric. Blast disease of rice. Galls and other abnormalities: stem gall of coriander leaf curl of Peach.

Unit-IV

Plant disease: Causal organism, symptoms and management

- Bacterial diseases: Citrus canker and Tundu disease of wheat.
- Viral diseases: Mosaics of tobacco, YVM of Okra, Leaf curl of papaya, and tungro of rice.
- Phytoplasmal diseases: Grassy shoot of sugarcane.

Suggested Readings

1. Agrios GN (2005) Plant Pathology, Academic Press, Burlington.
2. John AL (1998) Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press, Publication, Boca Raton, USA.
3. Dickinson CM (2003) Molecular Plant Pathology, Bios Scientific Publisher, Oxford.
4. Bridge PD, Clarkson JM (1998) Molecular Variability of Fungal Pathogens, CAB, International, Oxford shire.
5. Singh RS (2008) Plant Diseases, Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
6. Singh RS (2008) Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt. Ltd, New Delhi.
7. Dhingra OD, James B, Sinclair (1995) Basic Plant Pathology Methods, CRC
8. Concise Encyclopedia of Plant Pathology by P. Vidhyasekaran

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Practical:

1. Isolation of bacterial and fungal plant pathogens of crop plants.
2. Study of mineral deficiency diseases of Tomato and French bean.
3. Measurement of fungal spore.
4. Preparation of culture media and sterilization.
5. A study of symptomology, histopathology and identification of pathogen of various fungal diseases listed above.
6. Inoculation experiment with fungal and bacterial plant pathogen.
7. Field collection of 50 diseases plant specimen (fungal, viral and bacterial)
8. Study of Fungal bio-control agents

M.Sc., Semester Third

Paper I, Plant Physiology and Biochemistry — Credits 4

Unit-I

Water relation; Absorption and transportation and loss of water, Transpiration regulation of opening and closing in stomata. Mineral Nutrient; Criteria of essentiality of mineral nutrients, mineral metabolism essential and non-essential elements, deficiency and toxicity of elements. Absorption and translocation of minerals, biological nitrogen fixation and metabolism. Photoperiodism and vernalization, and plant movements.

Unit-II

Photosynthesis; light harvesting complex of higher plants light reaction of photosynthesis, photosynthetic carbon reduction pathway, Hatch slack pathway and crassulacean acid metabolism (CAM). Respiration; Types of respiration, mechanism, glycolysis, Tricarboxylic acid cycle, Electron Transport System, Fermentation, respiration quotient and photorespiration. Plant growth regulators, Auxins, Gibberellins, cytokinins, Ethylene, ABA (abscisic acid), Brassinosteroids, Jasmonates, Salicylic acid.

Unit-III

Biomolecules; Structure and function of carbohydrates, amino acids, protein and lipids. Enzymes; regulatory and active sites, activation energy and isozymes. Enzyme kinetics Michaelis-Menten equation, classification of enzymes, prosthetic groups and co-factors.

Unit-IV

Bioenergetics; Laws of thermodynamics and its application biological system, concept of entropy, enthalpy and free energy. High energy compounds. Biochemical techniques; Chromatography, electrophoresis, centrifugation, spectrophotometry and tracer techniques

Suggested Readings:

1. Devlin RM & Witham FH (1986). Plant Physiology. CBS Publs. and Distributors, New Delhi.
2. Hopkins WG (1995). Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
3. Moore TC (1989). Biochemistry and Physiology of Plant Hormones. SpringerVerlag. New York, USA.

4. Singhal *et al.,* (1999). Concepts in Photobiology. Photosynthesis and Phytomorphognesis, Narosa Pub. House, N. Delhi.
5. Taiz & Zeigler (2006). Plant Physiology 4th Edn. Sinauer Associates Inc., Publishers, Sunderland
6. Salisbury FB & Celon W (1986). Plant Physiology 3d Edn. CBS Publishers, New Delhi.
7. Voet & Voet (1995). Biochemistry 2nd Edn, John Wiley & Sons, Inc., New York, USA.
8. Nelson DL& Cox MM (2000). Lehninger Principles of Biochemistry. Macmillan Worth Publishers, Madison Av., New York
9. Lehninger AL (1993). Principle of Biochemistry. CBS Publishers, New Delhi.
10. Cooper, A (2004). Biophysical Chemistry. Royal Society of Chemistry, Cambridge Publication.
11. Hames, BD, Hooper NM & Houghton JD (1998). Instant Notes in Biochemistry. Viva Books, NewDelhi .
12. Wildon K& Walker J (2000). Practical Biochemistry: Principles and Techniques 5th Edn, Cambridge University Press.
13. Skoog, DA, Holler FJ & Timothy N (1998). Principles of Instrumental Analysis 5th Edn. Sauders College Publishing.
14. Wise DL (1991). Bioinstrumentation and Biosensors. Marcel Dekker, New York.

Practicals:

1. Determination of osmotic pressure, diffusion pressure deficit and water potential.
1. Extraction of protein from germinating seeds of black gram.
2. Extraction of amino acids.
3. Determination of structure, size and frequency of stomata.
4. Determination of transpiration by potometer.
5. Study of effects of CO_2 concentration and light intensity on rate of photosynthesis.
6. Separation of major plant pigment by paper chromatography (PC) and TLC.
7. Separation of mixture of amino acid by PC and TLC.
8. Determination of amylase activity
9. Estimation of protein by Biuret method
10. Determination of chlorophyll a, chlorophyll b and total chlorophylls in C3 and C4 plants.

Paper II Plant Biotechnology and Molecular Biology Credit 4

Unit-I

Genetic Engineering of Plants: Objectives, strategies and approaches; transformation methods: Agrobacterium mediated biolistic approach, microinjection, electroporation and liposome mediated selection of transformants and their molecular characterization.

Unit-II

Production of Transgenic plants viz herbicide resistant plants; engineering Plants for abiotic stress, senescence- tolerance and male sterility, environmental, social and legal implications. Production of genetically modified (GM) plants.

Unit-III

DNA replication; General Feature of Replication, DNA polymerase mechanism and their specialization, Mechanism of DNA Replication, initiation, elongation and termination) in prokaryotes and eukaryotes

Unit-IV

Gene and chromosome, Chromatin, Histone and their variants, Nucleosomes: Nucleosomes assembly and Histone modification, A, B and Z DNA. Denaturation and Renaturation kinetics.

Suggested Readings:

1. Hill W E (2000). Genetic Engineering. Hardwood Academic Publishers, the Netherlands.
2. Brown T (1995). Gene Cloning. Chapman & Hall, London.
3. Ranjan R (1996). Transgenic Plant. Agro Botanical, Bikaner
4. Setlor J (1999). Genetic Engineering. Plenum Press, New York.
5. Tombs M (1990). Biotechnology and Genetic Engineering Reviews. Intercept, U.K.
6. Old RW& Primrose SB (1985). Principle of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell
7. Alberts B, Bray D, Lewis J, Raf M, Roberts K& Watson JD (1989). Molecular Biology of the Cell, Garland Publishing inc., New York
8. Alcamo IE (1994). Fundamentals of Microbiology, The Benjamin/Cummings Publishing Co., New York.
9. Benjamin Lewin (2007). Genes IX, Prentice Hall.
10. Brachet J & Mirsky AE (1959). The Cell, Academic Press, Vols.
11. Brown WV & Berke MB (1974). Text Book of Cytology, Blackstains Sons & Co.
12. De Robertis EDP & De Robertis EMF (2001). Cell and Molecular Biology, Lippincott Williams & Wilkins, Bombay.
13. Evans DA Sharp WR & Amirato PY (1986), Handbook of Plant Tissue Culture.

Macmillan Publishing Company, New York.
14. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D & Darnell J (2000). Molecular Cell Biology. W.H. Freeman and Co., New York, USA.

Practicals:

1. Preparation of tissue culture media.
2. Surface sterilization of ex plant.
3. Organ culture.
4. Callus propagation, organogenesis, transfer of plant to soil.
5. Protoplast isolation and culture.
6. Extraction of DNA plant tissue.
7. Separation of DNA fragment by gel electrophoresis

Paper III-A, Plant Resource Utilization and Conservation — Credit 4

Unit-I

Plant Introduction, Domestication, importance history, botany, cultivation and processing of cereals (Wheat, Maize, Rice) legumes/Pulses (*Pisum, Cicer, Cajanus*), Fiber plants and their products Cotton (*Gossypium*), Jute (*Corchorus* sp), Sunhemp (*Crotolaria* sp)

Unit-II

Medicinal plants opium poppy (*Papaver somniferum*), sharpgandha (*Rauwolfia serpentina*) Tulsi (*Ocimum*), Giloy (*Tinospora cordifolia*), and narcotics. Fumitories & masticatories', Beverage yielding plants, important wood and timber yielding plants Sissoo (*Dalbergia Sissoo),* Sal (*Shorea robusta*), Teak (*Tectona grandis*), sugar and sugar yielding plants Sugar cane (*Saccharum officinarum)* Beet root (*Beta vulgaris*).

Unit-III

Principles of conservation; in-situ and ex-situ conservation principles and practices NSC, Botanic gardens, BSI, NBPGR, ICAR, CSIR, DST and DBT & germplasm conservation.

Unit-IV

Plant biodiversity (Type and measurement), Seed banks and cryobanks, green revolution – benefits, Red Data Book, Sustainable development

Suggested Readings:

1. Jain SK, Sinha BK & Gupta RC (1991). Notable Plants in Ethnomedicine of India. Deep Publications, New Delhi.
2. Chowdhery HJ & Murti SK (2000). Plant Biodiversity and Conservation in India: An Overview. Bishen Singh, Mahendraçal Singh, Dehradun.
3. Jain SK (1991). Contribution of Indian Ethnobotany. Scientific Publishers, Jodhpur.
4. Singh VK & Abrar MK (1990). Medicinal Plants and Folkories. Today & Tomorrows Printers&&Publishers, New Delhi.
5. Ghosh, AK (2008). A Comprehensive Handbook on Biodiversity, TERI, New Delhi.

Practicals:

1.
2. Study of cereal and sugar yielding plants.
3. Study of fiber yielding plants.
4. Study of timber wood.
5. Survey and collection of at least 20 medicinal plants from your locality

Paper III-B, Soil Science and Phytogeography — Credit 4

Unit-I

Soils; Its origin and development, weathering, pedogenesis and soil profile. Soil forming Processes; Humification, podozolization, laterization, gleization and Calcification.

Unit-II

Physical Properties of soil; Texture, Structure, Density, Porosity and permeability. Soil-water quantities and their measurement. Soil-water energy concept. Laws governing air and water movement in the soil.

Unit-III

Soil chemical properties; Chemical nature of soil, soil solution and nutrients, soil pH, Cation exchange phenomenon, Acidity, alkalinity and Salinity of soil. Soil organisms and their roles to higher plants, Soil erosion and conservation.

Unit-IV

Phytogeography; Distribution Patterns, Barriers, endemic. Concept of hotspot, age-area hypothesis, Vegetational and floristic region of India.

Suggested Readings:

1. Brady, N.C. and R.R. Weil (2013). The Nature and Properties of Soil, Pearsons Publication, New Delhi
2. Henry D. Foth (1991). Fundamentals of Soil Science. Wiley New York
3. Biswas, T and S.K. Mukherjee (2017) Textbook of Soil Science, McGraw Hill, Noida
4. Shukla, R.S. and P.S. Chandel (2010). A Textbook of Plant Ecology, S. Chand and Company, New Delhi

Practicals:

1. Determination Water holding capacity, Bulk Density, Porosity, and Permeability of soil
2. Determination of soil moisture.
3. Quick test for carbonate, nitrate and Phosphate
4. Determination of pH of soil by PH meter
5. Determination of conductivity of soil

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M.Sc., Semester Four

Paper I-A, Plant Ecology **Credit 4**

Unit-I

Concept and Scope of Ecology, Interaction of factors and ecological niche. Plant communities; dynamics and development succession and climax. Ecological adaptations and plant indicators.

Unit-II

Population ecology; natality, mortality, survivorship and growth curves, biotic potential, carrying capacity and environmental resistance, r and K selection. Gene Ecology; Ecotypes, Ecophenes and Ecads.

Unit-III

Ecosystem: Concept of ecosystem, trophic structure, food chain, energy flow, productivity and energy subsidy, biological diversity and mega diversity countries.

Unit-IV

Biogeochemical cycles; carbon, nitrogen, phosphorus and sulphur cycles. Idea of major terrestrial and aquatic ecosystems: Tundra, grasslands, forests, desert and wetlands, lakes, ocean and estuaries.

Suggested Readings:

1. Pierzynski GM, Sims JT & Vance GF (2005). Soils and Environmental Quality. CRC, London.
2. Perk M (2006). Soil and Water Contamination from Molecular to Catchment Scale. Taylor & Francis. The Netherland.
3. Coley D (2008). Energy & Climate Change. John Wiley & Sons, London.
4. Tanez JG, Hernandez-Esparza M, Doria-Serano C, Fregoso-Infante A & Singh MM (2007). Environmental Chemistry, Fundamentals. Springer.
5. Suresh G (2007). Environmental Studies and Ethics. IK International, New Delhi.
6. Odum EP & Barrett GW (2005). Fundamentals of Ecology. V Edn, Thomson Asia, Pvt. Ltd.
7. Chapman JL & Reiss MJ (1995). Ecology Principles & Applications. Cambridge University Press.
8. Kormondy, Edward J. (2006). Concept of Ecology. Prentice Hall, New Delhi
9. Shukla, R.S. and P.S. Chandel (2010). A Textbook of Plant Ecology, S. Chand and Company, New Delhi

Practicals:

1. Determination of Abundance, Density, Frequency and Dominance by quadrat method.
2. Determination of similarity and dissimilarity Indices
3. Estimation of Carbonate, Bicarbonate, Chloride and Dissolved Oxygen from fresh water ecosystems
4. Morphological anatomical and physiological adaptations in Hydrophytes, Xerophyte and Epiphytes

Paper I-B, Water Resource Management — Credit 4

Unit-I

Distribution of water resources, Lentic and Lotic Water bodies, Aquifers, Hydrological cycle, catchment infiltration, water shed management

Unit-II

Physico-chemical properties of fresh water, water quality Parameter and standards. Water pollution and its sources, ground water.

Unit-III

Water stress adaptation in plant, Role of plants in water management, Water borne diseases, water management strategies, management of ground water, rain water harvesting, Recharging of ground water, recycling of waste water.

Unit-IV

Water prevention and control of pollution, Treatment technologies, Treatment of drinking water (Ion exchange, Reverse osmosis and water disinfection), Treatment technology, Domestic waste water treatment.

Suggested Readings:

1. Ghosh, AK (2008). Simplifying Climate Change. TERI, New Delhi.
2. Sampson, Garey P (2005). The WTO and Sustainable Development, TERI, New Delhi.
3. Somayaji and Somayaji G (2009). Environmental Concerns and Sustainable Development. TERI, New Delhi.
4. Saikia, Ranjane (2009). Making Sense of Climate Change. TERI, New Delhi.

Practicals:

1. Physical properties of water (colour, turbidity, taste, odour and total solids)
2. Chemical properties of water (carbonate, bicarbonate, acidity alkalinity and pH)
3. Coliform test for potability of water
4. Determination of BOD and COD of sewage
5. Lovejoy TE & Hannah L (2005). Climate Change and Biodiversity, TERI, New Delhi

Paper II-A, Cytogenetics, Plant Breeding and Biostatistics — Credit 4

Unit-I

Basic of Cytogenetics and their concepts: Cell Cycle and architecture of chromosomes in prokaryotes and eukaryotes, Chromonemata, chromosome matrix, chromomeres, centromere, telomere, artificial chromosome construction, Karyotyping, Chromosome banding and painting- In situ hybridization and various application., Chromosomes variation and their implications, Ploidy.

Unit-II

Applications of Cytogenetics: Fertilization in crop plant and their barriers, Role of polyploids and aneuploids in crop breeding, Evolutionary and genetic problem in crops, Synthesis of new crops (Wheat, Paddy, Cotton, Brassica) and hybridization between different species, Production of haploid and diploids and doubled haploids in crop breeding.

Unit-III

Measure of central tendency, Data analysis and Graphs, Binomial, Poisson and normal probability distribution, Chi-sq test and Null hypothesis, Parametric and Non-parametric statistics.

Unit-IV

T-test, Z-test, U-test and F-test, Regression and correlation and ANOVA, Standard deviation, Variance, Sampling distributions and Errors

Suggested Readings:

1. Razdan MK (1993). An Introduction of Plant Tissue Culture. Oxford &1BH, New Delhi.
2. Clark MS, Wall WJ (1996) Chromosomes: The Complex Code, Chapman & amp; Hall, London.
3. Sharma AK, Sharma A (1985) Advances in Chromosome and Cell Genetics, Oxford & IBH Publishing Co, Kolkata.
4. Krebs JE, Lewin B, Goldstein ES (2011) Genes X, Sudbury, Massachusetts.
5. Gupta PK (2007) Cytogenetic, Rastogi Publication, Meerut.
6. Gardner EJ, Simmons MJ, Snustad DP (2006) Principals of Genetics, 8th edition, John Wiley & Sons, Wiley India Edition.
7. Alberts B, Bray D, Lewis J, Ralf M, Roberts K, Watson JD (1999) Molecular
8. Biology of the Cell, Garland Publishing Inc, New York.

9. Allard RW (1999) Principles of Plant Breeding, 2nd edition, John Wiley and Sons, New York.
10. Hartl DL, Jones EW (2007) Genetics–Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers, Burlington.
11. David CA, et al., (2007) Epigenetic, 2nd edition, Cold Spring Harbor Laboratory Press, New York.
12. Spillane C, McKeown PC (2014) Plant Epigenetic and Epigenomics: Methods and Protocol, Springer Publisher, London.

Practicals:

1. Line diagrams showing the plan of different methods of breeding self-pollinated crops, Mass selection, pure line selection, Pedigree method,
2. Line diagrams showing the plan of different methods of breeding cross pollinated crops- BulkSelection, Recurrent selection.
3. Methods of hybridization in rice, sorghum, bajra, cotton in standing crop in the field.
4. Assignments with problems for computing measures of central tendency and dispersion- mean median and mode, standard deviation and standard error.
5. Assignment with problems for computing correlation and regression coefficients.
6. Assignment with problems for implementing t test.
7. Assignment with problems for computing ANOVA

Paper II-B, Forest Ecology — Credit 4

Unit-I

Human evolutionary dependence on forest: scope and relevance; forest types of India; Ecological morphology of rain forest flora

Unit-II

Structure of forest ecosystem: Photosynthetic efficiency; leaf area and growth Nutrient cycling in tropical forest ecosystems.

Unit-III

Reproductive strategy of tropical trees; Natural and artificial regeneration; Factor destructive to forest ecosystems; causes and effects of deforestation systems; Role of trees in combating air pollution.

Unit-IV

Physico-chemical properties of forest soil; ecological significance of soil texture; soil biology and soil fertility, Comparison of forest and grassland. Accumulation and decomposition of forest litter; forest humus; the geochemical and biogeochemical cycling of nutrients.

Suggested Readings:

1. Odum EP & Barrett GW (2005). Fundamentals of Ecology. V Edn, Thomson Asia, Pvt. Ltd.
2. Chapman JL & Reiss MJ (1995). Ecology Principles & Applications. Cambridge University Press.
3. Brady, NC, The nature and properties of soils, Prentice, Hall of India Pvt. Ltd.
4. Kormondy, Edward J. (2006). Concept of Ecology, Fourth Edition. Prentice Hall New Delhi

Practicals;

1. Determination of Abundance, Density, Frequency and Dominance by quadrat method.
2. Determination of similarity and dissimilarity Indices.
3. Methods of forest survey and study of forest maps and their preparation.
4. Study of forest vegetation by (i) Quadrat method (ii) Transect method (iii) Point method.
5. Preparation of forest profile diagram and study of stratification.
6. Determination of soil moisture, pH, Soluble salts, carbonate, soil texture and nitrate.
7. Determination Water holding capacity, Bulk Density, Porosity, and Permeability of soil.
8. Determination of conductivity of soil.

Paper III-A, Computer Application and Bioinformatics — Credit 4

Unit-I

Computer Fundamentals and programming Languages, Role of super computer in biology.

Unit-II

Historical background and scope of Bioinformatics, Transcriptomics and Proteomics, Metabolomics.

Unit-III

Data generation and data retrieval, generation of data, gene sequencing, Mass spectrometry,

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Microarray, Drug aided design, structure based and ligand based approaches, Molecular phylogeny, system biology and functional biology.

Unit-IV

Primary nucleotide sequence databases- EMBL, Gene bank, DDBJ. Protein sequence data bases- Swissprot/TrEMBL, PIR, Sequence motif data bases- Pfam, PROSITE. Dynamic Programming BLAST and FASTA, Phylogenetic analysis.

Suggested Readings:

1. Computer Fundamental: B. Ram
2. Fundamental of Information Technology: Leon & Leon
3. MS Office: BPB Publication
4. A First course in Computers: Sanjay Saxena
5. Computer Networks, Acme Learning: Anurajan Mishra
6. Gupta SP (1969). Statistical Methods, Sultan Chand & Sons, New Delhi.
7. Sundar Rao PSS & Richard J (1999). An Introduction to Biostatistics. A Manual for Students in Health Sciences, Prentice Hall of India Pvt. Ltd., New Delhi.
8. Rao S.S (1999) Networking Scenario in India New Lib-world 100(4) 160-68
9. Schena, M.2003. Microarray Analysis John Wiley Publication New York.
10. Prevsner, J.2005. Bioinformatics & Functional Genomics John Wiley & sons new jersey.

Practicals:

1. Working in MS Word, Excel and PPT
2. Elementary Practical Knowledge of C and Python
3. Use of software for molecular Phylogeny
4. Use of software for analysis of statistical data

Paper III-B, Environmental Management and Technology Credit 4

Unit-I

Biotic-abiotic interaction, Decline in Biodiversity and the consequences. Environmental Phenomenon and Episodes: Ozone layer depletion. Occupational Health Hazards: Silicosis, Asbestosis, Carcinogens, and Mutagens.

Unit – II

Nonrenewable and renewable energy resources; fossil fuels, nuclear power, biofuels, geothermal, hydro-electric power plants, solar power wind power. Environmental, economic and social advantages and disadvantages of these energy resources.

Unit – III

Composition of air, Major sources of air pollution. In- door air pollution, Monitoring of SO_X, NOx and ozone. Sources of solid waste, Solid waste disposal, disposal and management of biomedical and nuclear wastes. Noise Pollution and Abatement: Sources of noise pollution, Noise standards, Biological and behavioral effects of noise pollution.

Unit – IV

Environmental Impact Assessment: origin and development of EIA, International Agreements on Environment: Treaties and Protocols of United Nations Conference on Human Environment-UNCHE (Stockholm, **1972)**, National Environmental Policies and guidelines in India: Powers and functions of Central and State Pollution Control Boards, Prevention and Control of Air Pollution Act **1981.**

Suggested Readings:

1. Magill, PL., Holden, ER. & Ackley, C (1956). Air pollution Hand Book. MC Graw-Hill Book Co.
2. Coley, D. (2008). Energy & climate change, John Wiley & Sons. London.
3. Null, Air Pollution and plant life
4. Saxena, MM. Environmental analysis water soil and air
5. Fulekar, M. H. Environmental Biotechnology
6. Sawicki, E. Handbook of environmental genotoxicology
7. Lyons, J. J. Principles of air pollution meteorology
8. Mc Caul, J. Water Pollution

Practical:

1. Physical properties of water (colour, turbidity, taste, odour and total solids)
2. Chemical properties of water (hardness, Calcium, magnesium, carbonate, bicarbonate, acidity alkalinity and pH)
3. Determination of BOD and COD of sewage.
4. Determination of fluoride and arsenic from ground water

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Dr. Abdullah (Convener) | Prof. Anil Kumar Dwivedi (External Expert) | Dr. M. Zeeshan Beg (External Expert) | Prof. M. Jaish Beg (P.G. Member)

Dr. M. Ahsan Beg (P.G. Member) | Shri Rajnish Bharati (U.G. Member) | Shri Amit Kumar Patel (U.G. Member)