

SYLLABUS
FOR
B.Sc. BOTANY
(Change of Discipline Test)

BOC 101: BIODIVERSITY I (Microbes, Algae, Fungi and Bryophytes)

THEORY:

Total Lectures: 60

Unit 1: Microbes

(15 Lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Types - archaeobacteria, eubacteria and mycoplasma. Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae

(15 Lectures)

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Smith's classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Spirogyra*, *Sargassum* and *Polysiphonia*. Economic importance of algae with special reference to food, biofertilizers and medicine.

Unit 3: Fungi

(15 Lectures)

Introduction - General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction, Ainsworth's classification and economic importance with special reference to medicine; Life cycle of *Rhizopus* (Zygomycota), *Penicillium* (Ascomycota) and *Agaricus* (Basidiomycota); Symbiotic Associations - Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4: Bryophytes

(15 Lectures)

General characteristics, range of thallus organization. Smith's classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Anthoceros* and *Funaria* (developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

SUGGESTED READINGS:

1. Kumar, H.D. 1999. *Introductory Phycology*. 2nd edition. Affiliated East-West Press Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R. and Case, C.L. 2010. *Microbiology: An Introduction*. 10th edition. Pearson Benjamin Cummings, U.S.A.
3. Sethi, I.K. and Walia, S.K. 2011. *Text Book of Fungi & Their Allies*. MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. *Introductory Mycology*. 4th edition. John Wiley and Sons (Asia), Singapore.
5. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. 2005. *Biology*. Tata McGraw Hill, Delhi.
6. Smith, G.M. 1955. *Cryptogamic Botany. Vol. I. Algae and Fungi*. 2nd edition. McGraw-Hill, New York.

7. Smith, G.M. 1955. *Cryptogamic Botany. Vol. II. Bryophytes and Pteridophytes*. 2nd edition. McGraw-Hill, New York.
 8. Vashishta, B.R. and Sinha, A.K. 2011. *Botany for Degree Students: Bryophyta*. S. Chand & Company Pvt. Ltd., New Delhi.
 9. Vashishta, B.R. and Sinha, A.K. 2014. *Botany for Degree Students: Fungi*. S. Chand & Company Pvt. Ltd., New Delhi.
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BOC 102: BIODIVERSITY II (Vascular Plants)

THEORY:

Total Lectures: 60

Unit 1: Pteridophytes (12 Lectures)

General characteristics, classification; early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

Unit 2: Gymnosperms (10 Lectures)

General characteristics, classification (Coulter & Chamberlain), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (developmental details not to be included). Ecological and economical importance.

Unit 3: Documentation and identification (8 Lectures)

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access.

Unit 4: Taxonomic hierarchy (2 Lectures)

Ranks, categories and taxonomic groups.

Unit 5: Botanical nomenclature (6 Lectures)

Principles and rules (IUCN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 6: Classification to plant taxonomy (18 Lectures)

Classification and nomenclature. Types of classification - artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto order); Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. Study of families: Asteraceae, Solanaceae, Lamiaceae, Liliaceae and Poaceae.

Unit 7: Biometrics, numerical taxonomy and cladistics (4 Lectures)

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

SUGGESTED READINGS:

1. Vashishta, P.C., Sinha, A.K. and Kumar, A. 2010. *Pteridophyta*. S. Chand, Delhi, India.
 2. Bhatnagar, S.P. and Moitra, A. 1996. *Gymnosperms*. New Age International (P) Ltd., New Delhi, India.
 3. Parihar, N.S. 1991. *An Introduction to Embryophyta. Vol. I. Bryophyta*. Central Book Depot, Allahabad.
 4. Simpson, M.G. 2006. *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
 5. Singh, G. 2012. *Plant Systematics: Theory and Practice*. 3rd edition. Oxford & IBH Pvt. Ltd., New Delhi.
 6. Vashishta, B.R., Sinha, A.K. and Kumar, A. 1971. *Botany for Degree Students: Pteridophyta*. S. Chand & Company Pvt. Ltd., New Delhi.
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BOC 103: PLANT ANATOMY AND EMBRYOLOGY

THEORY:

Total Lectures: 60

Unit 1: Meristematic and permanent tissues

(4 Lectures)

Root and shoot apical meristems; simple and complex tissues.

Unit 2: Primary structure of organs

(4 Lectures)

Structure of dicot and monocot root, stem and leaf.

Unit 3: Secondary growth

(10 Lectures)

Activity of vascular cambium, Anomalous secondary growth in stems of *Boerhaavia*, *Bignonia* and *Dracaena*; Wood Anatomy - Wood elements, heartwood and sapwood, Tension Wood; Economic importance of wood and wood elements. Periderm and Rhytidome: Structure and functions.

Unit 4: Adaptive and protective systems

(8 Lectures)

Epidermis, cutin, cuticle and other types of coverings, epidermal appendages, stomatal types, adaptations in Hydrophytes, Xerophytes and Halophytes.

Unit 5: Structural organization of flower

(15 Lectures)

Flower as modified reproductive shoot; structure of anther and pollen; development of male gametophyte; structure and types of ovules; development of female gametophyte; ultrastructure of mature embryo sac; types of embryo sacs: monosporic - *Polygonum* type, bisporic - *Allium* type, tetrasporic - *Peperomia* type.

Unit 6: Pollination and fertilization

(5 Lectures)

Pollination mechanisms and adaptations; insect pollination as an evolved mechanism, Double fertilization.

Unit 7: Embryo and endosperm, seed structure (10 Lectures)

Structure of dicot and monocot embryo; Endosperm types and functions, structure of mature seed, Endospermous seeds. Fruit and seed dispersal mechanisms and adaptations.

Unit 8: Apomixis and polyembryony (4 Lectures)

Concepts, types and practical applications.

SUGGESTED READINGS:

1. Esau, K. 2006. *Anatomy of Seed Plants*. 2nd edition. Wiley Eastern Private Ltd., New Delhi.
2. Arthur, J.E. and Mac Daniels, L.H. 1977. *An Introduction to Plant Anatomy*. 2nd edition. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
3. Bhojwani, S.S. and Bhatnagar, S.P. 2011. *Embryology of Angiosperms*. 5th edition. Vikas Publication House Pvt. Ltd., New Delhi.
4. Fahn, A. 1990. *Plant Anatomy*. 4th edition. Pergamon Press.
5. Pandey, S.N. and Chadha, A. 1993. *A Textbook of Botany: Plant Anatomy and Economic Botany. Vol. III*. Vikas Publishing House Pvt. Ltd., New Delhi.
6. Bhojwani, S.S., Bhatnagar, S.P. and Dantu, P.K. 2015. *The Embryology of Angiosperms*. 6th edition. Vikas Publishing House Pvt. Ltd., Noida.
7. Pandey, B.P. 2014. *Plant Anatomy*. S. Chand & Company Pvt. Ltd., New Delhi.

BOC 104: PLANT PHYSIOLOGY

THEORY:

Total Lectures: 60

Unit 1: Plant-water relations (8 Lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2: Mineral nutrition (8 Lectures)

Essential elements, macronutrients and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport carriers, channels and pumps.

Unit 3: Translocation in phloem (6 Lectures)

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Enzymes (4 Lectures)

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 5: Photosynthesis (12 Lectures)

Photosynthetic pigments (Chl. a, Chl. b, xanthophylls, carotenes, phycobillins); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C₃, C₄ and CAM pathways of carbon fixation; Photorespiration.

Unit 6: Respiration (6 Lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 7: Nitrogen metabolism (4 Lectures)

Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (6 Lectures)

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA and ethylene.

Unit 9: Plant response to light and temperature (6 Lectures)

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far-red light responses on photomorphogenesis; Vernalization.

SUGGESTED READINGS:

1. Taiz, L. and Zeiger, E. 2010. *Plant Physiology*. 5th edition. Sinauer Associates Inc., U.S.A.
2. Hopkins, W.G. and Huner, N.P. 2009. *Introduction to Plant Physiology*. 4th edition. John Wiley & Sons, U.S.A.
3. Bajracharya, D. 1999. *Experiments in Plant Physiology - A Laboratory Manual*. Narosa Publishing House, New Delhi.
4. Nagar, S. and Adhav, M. 2009. *Practical Biotechnology and Plant Tissue Culture*. S. Chand & Company Pvt. Ltd., New Delhi.

BOC 105: CLASSICAL TAXONOMY AND PHYLOGENY

THEORY:

Total Lectures: 60

Unit 1: Morphology of angiosperms (25 Lectures)

Definition, Characteristics and functions; different types and modifications of following: Roots- Tap, fibrous and adventitious, etc; Stem- Aerial and underground; Leaf- phyllotaxy and its significance, forms/shapes of leaves, leaf incision/types, leaf margins, leaf apex, leaf surface, leaf texture, leaf venation, types of leaves, associated outgrowths, modification of stipules; leaf modifications, vernation; buds; Inflorescence types; Flower- parts, symmetries, characters, types, functions of different parts of the flower, aestivation types; Fruit - types: Simple, Aggregate, Multiple; Seeds - different types.

Unit 2: Systematic position (Bentham and Hooker's classification), diagnostic features and important ornamental/economical/medicinal species of the following families:

(21 Lectures)

Annonaceae, Capparidaceae, Brassicaceae, Tiliaceae, Rutaceae, Myrtaceae, Leguminosae (Caesalpiniaceae, Papilionaceae, Mimosaceae), Cucurbitaceae, Rubiaceae, Apocynaceae,

Asclepiadaceae, Verbenaceae, Amarantaceae, Moraceae, Orchidaceae, Araceae, Arecaceae, Musaceae, Commelinaceae.

Unit 3: Origin and evolution of angiosperms (7 Lectures)

A general account with special reference to Bennettitalean, Gnetalean, Caytonialean and Herbaceous origin theories; primitive living angiosperms; evolution of flower; co-evolution of flowers and insects.

Unit 4: Phylogeny of angiosperms (7 Lectures)

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades). Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

SUGGESTED READINGS:

1. Davis, P.H. and Heywood, V.H. 1963. *Principles of Angiosperm Taxonomy*. Oliver & Boyd, London.
2. Heywood, V.H. and Moore, D.M. 1984. *Current Concepts in Plant Taxonomy*. Academic Press, London.
3. Jones, Jr. S.B. and Luchsinger, A.E. 1986. *Plant Systematics*. 2nd edition. McGraw-Hill Book Co., New York.
4. Lawrence, G.H.M. 1951. *Taxonomy of Vascular Plants*. MacMillan, New York.
5. Naik, V.N. 1984. *Taxonomy of Angiosperms*. Tata McGraw Hill, New Delhi.
6. Radford, A.E. and Caddell, G.M. 1986. *Fundamentals of Plant Systematics*. Harper & Row, New York.
7. Singh, G. 2012. *Plant Systematics: Theory and Practice*. 3rd edition. Oxford & IBH Pvt. Ltd., New Delhi.
8. Jeffrey, C. 1982. *An Introduction to Plant Taxonomy*. 2nd edition. Cambridge University Press, Cambridge, London.
9. Stace, C.A. 1989. *Plant Taxonomy and Biosystematics*. 2nd edition. Hodder Arnold, London.
10. Woodland, D.W. 1991. *Contemporary Plant Systematics*. Prentice Hall, New Jersey.
11. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. 2002. *Plant Systematics - A Phylogenetic Approach*. 2nd edition. Sinauer Associates Inc., Cary, NC.
12. Maheshwari, J.K. 1963. *Flora of Delhi*. CSIR, New Delhi.

BOC 106: CELL BIOLOGY AND PLANT BIOCHEMISTRY

THEORY:

Total Lectures: 60

Cell Biology:

Unit 1: Techniques in cell biology

(6 Lectures)

Principle, working and applications of the following techniques: Phase contrast microscopy; Fluorescence microscopy; Electron microscopy (SEM and TEM); Micrometry and Photomicrography.

Unit 2: Cell and its components

(20 Lectures)

Cell - Cell theory; structure of prokaryotic and eukaryotic cells.

Cell wall - chemical composition, ultrastructure and functions.

Cell Membrane - chemical composition, structure (Fluid Mosaic Model) and functions; fluidity of membrane.

Nucleus - structure of nuclear envelope, nucleoplasm, chromatin (euchromatin and heterochromatin) and nucleolus.

Plastids - types of plastids; morphology, ultrastructure and function of Chloroplast.

Mitochondria - origin, morphology, ultrastructure and function.

Ribosomes - structure of prokaryotic and eukaryotic ribosomes and their functions.

Cytoskeleton - structure and function of microtubules, microfilaments and intermediate filaments.

Other cell organelles - structure and functions of Endoplasmic Reticulum, Golgi apparatus, Lysosomes, Peroxisomes and Glyoxisomes.

Unit 3: Cell Division

(4 Lectures)

Overview of cell cycle; cell division (mitosis and meiosis) and its significance.

Plant Biochemistry:

Unit 4: Biomolecules

Carbohydrates:

(5 Lectures)

Classification and biological role of carbohydrates; structure and properties of monosaccharides (glucose and fructose), oligosaccharides (sucrose and maltose) and polysaccharides (starch and cellulose); synthesis and degradation of starch in plants.

Amino acids and proteins:

(10 Lectures)

Amino acids - classification, structure, properties and biological role of amino acids; essential and non-essential amino acids; transamination.

Proteins - classification, structure (primary, secondary, tertiary and quaternary), properties and biological role of proteins; protein synthesis (transcription and translation); post-translational changes.

Lipids: (4 Lectures)

Classification, structure, properties and biological role of fatty acids and lipids; synthesis and breakdown of triglycerides; β -oxidation.

Nucleic acids: (4 Lectures)

Structure of nucleic acids (nitrogen bases, nucleosides and nucleotides); structure of B-DNA; alternate forms of DNA (A, C, D and Z); RNA and its types.

Vitamins: (4 Lectures)

Broad classification of vitamins; properties, occurrence, functions and deficiency symptoms of vitamins A, B complex, C, D, E and K.

Unit 5: Secondary metabolites (3 Lectures)

Broad classification of secondary metabolites; properties and functions of terpenoids, alkaloids and phenolics.

SUGGESTED READINGS:

1. Kleinsmith, L.J. and Kish, V.M. 1995. *Principles of Cell and Molecular Biology*. 2nd edition. Harper Collins College Publishers, New York.
2. Gupta, P.K. 1999. *A Text Book of Cell and Molecular Biology*. Rastogi Publications, Meerut, UP.
3. Karp, G. 2010. *Cell and Molecular Biology: Concepts and Experiments*. 6th edition. John Wiley & Sons Inc.
4. Avers, C.J. 1986. *Molecular Cell Biology*. Addison-Wesley Publishing Co., Boston.
5. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. 2009. *The World of the Cell*. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
6. Campbell, M.K. 2012. *Biochemistry*. 7th edition. Cengage Learning, Boston.
7. Campbell, P.N. and Smith, A.D. 2011. *Biochemistry Illustrated*. 4th edition. Churchill Livingstone, London.
8. Jain, J.L., Jain, S. and Jain, N. 2007. *Elementary Biochemistry*. 3rd edition. S. Chand and Company Ltd., New Delhi.
9. Mathur, R. and Mehta, M. 2002. *Biochemistry*. 1st edition. Anmol Publications Pvt. Ltd., New Delhi.
10. Berg, J.M., Tymoczko, J.L. and Stryer, L. 2011. *Biochemistry*. W.H. Freeman and Company, New York.
11. Nelson, D.L. and Cox, M.M. 2008. *Lehninger Principles of Biochemistry*. 5th edition. W. H. Freeman and Company, New York.
12. Stryer, L. 1995. *Biochemistry*. W.H. Freeman and Co., New York.
13. Campbell, M.K. 1999. *Biochemistry*. Saunders College Publishing, Philadelphia.
14. Verma, S.K. and Verma, M. 2007. *A Textbook of Plant Physiology, Biochemistry and Biotechnology*. 6th edition. S. Chand and Company Ltd., New Delhi.
15. Sadasivam, S. and Manickam, A. 1996. *Biochemical Methods*. New Age International Publishers.

16. Boyer, R. 2001. *Modern Experimental Biochemistry*. 3rd edition. Pearson Education, Singapore.
 17. Wilson, K. and Goulding, K.H. 1986. *A Biologists Guide to Principles and Techniques of Practical Biochemistry*. Edward Arnold, London.
 18. Rao, B.R. and Deshpande, S. 2005. *Experimental Biochemistry*. I.K. International Pvt. Ltd., New Delhi.
 19. Nigam, A. and Ayyagari. 2007. *Lab Manual in Biochemistry, Immunology and Biotechnology*. Tata McGraw-Hill Publishing Company Limited, New Delhi.
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BOC 107: MICROBIOLOGY AND PLANT PATHOLOGY

THEORY:

Total Lectures: 60

Microbiology:

Unit 1: Introduction to microbiology

(5 Lectures)

Terms and definitions; aseptic technique and concept of sterilization; physical and chemical methods of sterilization; biosafety levels and biohazards in the laboratory; disposal of laboratory wastes and cultures.

Unit 2: Methods in microbiology

(6 Lectures)

Types and preparation of culture media; methods of obtaining pure cultures of microorganisms (streak plate, spread plate and pour plate); enumeration of microorganisms (direct and indirect methods); bacterial motility; bacterial growth curve.

Unit 3: Preservation and maintenance of microbial cultures

(3 Lectures)

Methods of preservation (periodic transfer, lyophilisation, use of mineral oil and liquid nitrogen); culture collection centres (culture banks) and their importance.

Unit 4: Microbiology of air, soil and water

(7 Lectures)

Occurrence of microorganisms in air. Microorganisms in soil; role of microorganisms in decomposition of plant residues. Microorganisms in water; microorganisms as indicators of water pollution; bacteriological determination of potability of water (standard multiple tube fermentation and membrane filtration technique); methods of purification of water.

Unit 5: Applications of microorganisms

(9 Lectures)

Role of microorganisms in typical fermentation processes - fermented food and dairy products (bread, yoghurt and cheese); organic acids (citric acid and vinegar); alcoholic beverages made from fruit juices (grape and cashew apple); antibiotics (penicillin and streptomycin). Role of microorganisms in bioremediation; biodegradable plastics; production of biogas.

Plant Pathology:

Unit 6: Introduction to plant pathology: Terms and concepts; classification of plant diseases; disease symptoms caused by bacterial, fungal and viral plant pathogens; identification of plant disease – Koch's postulates. **(5 Lectures)**

Unit 7: Pathogen attack and defense mechanisms **(5 Lectures)**
Stages of disease establishment – the disease cycle; structural and biochemical defense mechanisms in plants (pre-existing and induced).

Unit 8: Plant disease epidemiology **(4 Lectures)**
Transmission and spread of plant pathogens; development of disease in plants - the disease triangle; plant disease epidemics (monocyclic and polycyclic).

Unit 9: Plant disease management **(9 Lectures)**
Physical, cultural, chemical, biological and IPM systems; development of transgenics for disease management; biopesticides; plant disease clinics.

Unit 10: Genetics of pathogenicity **(3 Lectures)**
Genes for virulence and avirulence and their role in susceptibility and resistance; molecular diagnosis - identification of genes and specific molecules in disease development (DNA and protein based diagnostic kits).

Unit 11: Application of modern technologies in plant pathology **(4 Lectures)**
Computer simulation of epidemics and disease forecasting; use of remote sensing and image analysis in plant pathology.

SUGGESTED READINGS:

1. Dubey, R.C. and Maheshwari, D.K. 1999. *A Text Book of Microbiology*. S. Chand and Company Ltd., New Delhi.
2. Sullia, S.B. 2001. *General Microbiology*. Oxford Publishers, New Delhi.
3. Sharma, K. 2011. *Text Book of Microbiology*. Anne Books Pvt. Ltd., New Delhi.
4. Kalaichelvan, P.T. and Pandi, A. 2007. *Bioprocess Technology*. MJP Publishers, Chennai.
5. Moshrafuddin, A. and Basumatany, S.K. 2006. *Applied Microbiology*. MJP Publishers, Chennai.
6. Meyneil, E. and Meynell, G.G. 1970. *Theory and Practice in Experimental Bacteriology*. Cambridge University Press, Cambridge.
7. Agrios, G.N. 1997. *Plant Pathology*. Academic Press, London.
8. Mehrotra, R.S. 1995. *Plant Pathology*. Tata McGraw-Hill Publishing Company Limited, New Delhi.
9. Sambamurty, A.V.S.S. 2006. *Text Book of Plant Pathology*. I.K. International Publishing House, New Delhi.
10. Albajes, R., Gullino, M.L., van Lenteren, J.C. and Elad, Y. 2000. *Integrated Pest and Disease Management in Greenhouse Crops*. Kluwer Academic Publishers.

11. Persley, G.J. 1996. *Biotechnologies and Integrated Pest Management*. CAB International, UK.
12. Bridge, P.D., Couteaudier, Y. and Clarkson, J.M. 1998. *Molecular Variability of Fungal Pathogens*. CAB International, UK.
13. Skerritt, J.H. and Apples, R. 1995. *New Diagnostics in Crop Sciences*. CAB International, UK.
14. Bridge, P.D., Arora, D., Reddy, C.A. and Elander, R.P. 1999. *Applications of PCR in Mycology*. CAB International, UK.
15. Bridge, P.D., Jeffries, P., Morse, D.R., Scott, P.R. and Boland, G.J. 1998. *Information Technology, Plant Pathology and Biodiversity*. CAB International, UK.
16. Eklund, C. and Lankford, C.E. 1967. *Laboratory Manual for General Microbiology*. Prentice-Hall, Inc., London.
17. Gunasekaran, P. 1995. *Laboratory Manual in Microbiology*. New Age International Pvt. Ltd.
18. Pawsey, R.K. 1974. *Techniques with Bacteria - A Guidebook for Teachers*. Hutchinson Educational.
19. Pelczar, M.J. and Chan, E.C.S. 1972. *Laboratory Exercises in Microbiology*. McGraw Hill Book Co.
20. Wistreich, G.A. and Lechtman, M.D. 1973. *Laboratory Exercises in Microbiology*. Macmillan Publishers, London.
21. Dubey, R.C. and Maheshwari, D.K. 2002. *Practical Microbiology*. S. Chand & Company Ltd., New Delhi.
22. Kale, V. and Bhusari, K. 2001. *Practical Microbiology: Principles & Techniques.*, Himalaya Publishing House, Mumbai.
23. Garg, N., Garg, K.L. and Mukerji, K.G. 2010. *Laboratory Manual of Food Microbiology*. I.K. International Publishing House Pvt. Ltd., New Delhi.
24. Aneja, K.R. 1993. *Experiments in Microbiology, Plant Pathology and Tissue Culture*. Wishwa Publication, New Delhi.
25. Mahadevan, A. and Sridhar, R. 1986. *Methods in Physiological Plant Pathology*. Sivakami Publication, Chennai.
26. Schaad, N.W. 1988. *Plant Pathogenic Bacteria: Laboratory Guide for Identification of Plant Pathogenic Bacteria*. Academic Press.
27. Sivakumar, P.K., Joe, M.M. and Sukesh, K. 2010. *An Introduction to Industrial Microbiology*. S. Chand & Company Pvt. Ltd., New Delhi.
28. Pandey, B.P. 2014. *Plant Pathology: Pathogen and Plant Disease*. S. Chand & Company Pvt. Ltd., New Delhi.

BOC 108: CYTOGENETICS AND PLANT BREEDING

Credits: 4 (Theory) + 2 (Practical)

THEORY:

Total Lectures: 60

Unit 1: Cell cycle

(2 Lectures)

Mitosis, Meiosis; Significance.

Unit 2: Mendelian genetics and its extension

(9 Lectures)

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Backcross and test cross; Incomplete dominance, co-dominance and lethal alleles; Gene interactions (Epistasis) – Dominant, Recessive, Complementary, Supplementary, Duplicate; Multiple alleles (blood groups in humans, self-incompatibility in plants), Pleiotropy, Penetrance and Expressivity.

Unit 3: Extrachromosomal inheritance

(4 Lectures)

Characteristics of extrachromosomal inheritance; Cytoplasmic inheritance in *Mirabilis jalapa*; Kappa particles in *Paramecium*; Mitochondria in yeast; Maternal effects in snail (shell coiling).

Unit 4: Linkage, crossing over and chromosome mapping

(6 Lectures)

Linkage, crossing over types and significance; Cytological basis of crossing over; Recombination frequency, two-point and three-point test crosses and their significance in chromosome mapping; Interference and coincidence.

Unit 5: Autosomes and sex chromosomes

(4 Lectures)

Mechanisms of sex determination; Balance concept of sex determination in *Drosophila*; Sex-linked inheritance; Sex-limited characters.

Unit 6: Alteration in chromosome number and structure

(8 Lectures)

Deletion, Duplication, Inversion, Translocation, meiosis in structural heterozygote; Position effect; Euploidy and Aneuploidy.

Unit 7: Gene mutations

(6 Lectures)

Types of mutations; Mutagens - physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Molecular basis of Mutations; Detection of mutations: CIB method.

Unit 8: Introduction to plant breeding

(3 Lectures)

Introduction and objectives; important achievements and undesirable consequences of plant breeding. Centres of origin and domestication of crop plants.

Unit 9: Methods of crop improvement

(11 Lectures)

Introduction and acclimatization; Selection methods for self-pollinated, cross-pollinated and vegetatively propagated plants; Hybridization: For self- and cross-pollinated plants –

Procedure, advantages and limitations. Role of mutation, polyploidy; Distant hybridization in crop improvement.

Unit 10: Quantitative inheritance

(4 Lectures)

Concept, mechanism, Monogenic v/s Polygenic Inheritance. Examples - Inheritance of kernel colour in wheat, ear length in maize.

Unit 11: Inbreeding depression and heterosis

(3 Lectures)

Inbreeding depression, Heterosis; Applications.

SUGGESTED READINGS:

1. Acquaaah, G. 2007. *Principles of Plant Genetics & Breeding*. Blackwell Publishing.
2. Chaudhari, H.K. 1984. *Elementary Principles of Plant Breeding*. 2nd edition. Oxford-IBH.
3. Gardner, E.J., Simmons, M.J. and Snustad, D.P. 1991. *Principles of Genetics*. 8th edition. John Wiley & Sons, India.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S. B. and Doebley, J. 2010. *Introduction to Genetic Analysis*. 10th edition. W. H. Freeman & Co., U.S.A.
5. Goswami, H.K. and Goswami, R. 1993. *Practical Cytology, Applied Genetics and Biostatistics*. 2nd revised edition. Himalaya Publishing House, Mumbai.
6. Klug, W.S., Cummings, M.R. and Spencer, C.A. 2009. *Concepts of Genetics*. 9th edition. Benjamin Cummings, U.S.A.
7. Singh, B.D. 2005. *Plant Breeding: Principles and Methods*. 7th edition. Kalyani Publishers, Ludhiana.
8. Snustad, D.P. and Simmons, M.J. 2010. *Principles of Genetics*. 5th edition. John Wiley & Sons Inc., India.
9. Verma, P.S. and Agarwal, V.K. 2009. *Genetics*. 9th revised edition. S. Chand & Co., New Delhi.
10. Shukla, R.S. and Chandel, P.S. 2013. *Cytogenetics, Evolution, Biostatistics and Plant Breeding*. 5th edition. S. Chand & Company Pvt. Ltd., New Delhi.

BOC 109: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

THEORY:

Total Lectures: 60

Unit 1: Nucleic acids - Carriers of genetic information

(2 Lectures)

Historical perspective; DNA/RNA as genetic material (Griffith's; Hershey & Chase; Avery, McLeod & McCarty; Fraenkel-Conrat's experiment).

Unit 2: The Structures of DNA and RNA/genetic material

(5 Lectures)

DNA Structure: Salient features of double helix (Watson and Crick), Types of DNA, Types of RNA, denaturation and renaturation, cot curves; Organization of DNA - Prokaryotes, Viruses, Eukaryotes. Structure of nuclear DNA v/s Organelle DNA.

Unit 3: The replication of DNA

(7 Lectures)

Genetic code; Central and revised dogma of molecular biology; General principles - Modes of replication, bidirectional replication. Models of DNA replication (Rolling circle, Theta replication and semi-discontinuous replication). Replication of linear dsDNA, Enzymes involved in DNA replication.

Unit 4: Transcription

(4 Lectures)

Enzymes in transcription; Basic features of transcription - initiation, elongation and termination, promoters and enhancers.

Unit 5: Translation

(4 Lectures)

Enzymes in translation; Basic features of translation - initiation, elongation and termination, Post-translational processing and modification.

Unit 6: Gene structure, regulation and modification of RNA

(10 Lectures)

Gene organization in prokaryotes and eukaryotes; gene regulation in prokaryotes and eukaryotes. Split genes - concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, alternative splicing; Eukaryotic mRNA processing and stability (5' cap, 3' poly A tail); Ribozymes; RNA silencing.

Unit 7: Recombinant DNA technology

(10 Lectures)

Definition of gene and recombinant DNA, steps in genetic engineering. Enzymes used in recombinant DNA technology (Restriction enzymes, DNA ligases, DNA modifying enzymes); Cloning Vectors: pBR322, Ti plasmid, YAC; λ phage, M13 phage, Cosmid; DNA isolation and sequencing (Sanger & Coulson, Maxam & Gilbert).

Unit 8: Methods of gene transfer

(5 Lectures)

Gene transfer (*Agrobacterium* - mediated and gene gun); Selection of transformants; selectable marker (antibiotic resistant markers, herbicide resistant markers) and reporter genes (Luciferase, GUS, GFP). Hairy root culture.

Unit 9: Gene cloning

(7 Lectures)

Construction of genomic and cDNA libraries, screening of DNA libraries; complementation, colony hybridization; Southern, Northern and Western blotting; Polymerase Chain Reaction. Techniques of DNA fingerprinting (RFLP, RAPD, AFLP).

Unit 10: Applications of genetic engineering

(6 Lectures)

Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Protease, Lipase); Genetically Engineered Products – Human Growth Hormone; Humulin; Superweeds; Bioethics and Biosafety concerns.

SUGGESTED READINGS:

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2007. *Molecular Biology of the Gene*. 6th edition. CSHL Press, New York, NY.
2. Snustad, D.P. and Simmons, M.J. 2010. *Principles of Genetics*. 5th edition. John Wiley and Sons Inc., U.S.A.
3. Klug, W.S., Cummings, M.R. and Spencer, C.A. 2009. *Concepts of Genetics*. 9th edition. Benjamin Cummings, U.S.A.
4. Russell, P.J. 2010. *i-Genetics - A Molecular Approach*. 3rd edition. Benjamin Cummings, U.S.A.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B. and Doebley, J. 2010. *Introduction to Genetic Analysis*. 10th edition. W. H. Freeman and Co., U.S.A.
6. Glick, B.R. and Pasternak, J.J. 2003. *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. ASM Press, Washington D.C.
7. Stewart, C.N. Jr. 2008. *Plant Biotechnology & Genetics: Principles, Techniques and Applications*. John Wiley & Sons Inc., U.S.A.
8. Dubey, R.C. 1993. *A Textbook of Biotechnology*. S. Chand & Company Pvt. Ltd., New Delhi.
9. Verma, P.S. and Agarwal, V.K. 2009. *Molecular Biology*. S. Chand & Company Ltd., New Delhi.
10. Purohit, S.S. 2008. *Biotechnology: Fundamentals and Applications*. Agrobios, Jodhpur.
11. Nagar, S. and Adhav, M. 2009. *Practical Biotechnology and Plant Tissue Culture*. S. Chand & Company Ltd., New Delhi.

BOC 110: PLANT ECOLOGY AND PHYTOGEOGRAPHY

THEORY:

Total Lectures: 60

Unit 1: Introduction

(3 Lectures)

Concept of Ecosystem, components and organization, structure and function, trophic organization.

Unit 2: Soil

(8 Lectures)

Importance; Origin; Formation; Composition: Physical, chemical and biological components. Soil profile: type of soil; its effect on vegetation.

Unit 3: Water

(4 Lectures)

Importance; States of water in the environment: Water in soil, Water table; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological cycle.

Unit 4: Ecological factors

(3 Lectures)

Atmospheric humidity and precipitation in relation to plants.

Unit 5: Biotic interaction

(5 Lectures)

Basic source of energy, autotrophy, heterotrophy, symbiosis, commensalism, parasitism; food chain; ecological pyramids; biomass; standing crop.

Unit 6: Plant communities

(8 Lectures)

Definition, analytic, quantitative and synthetic characteristics; life forms; habitat and niche; Ecotone and edge effect; Dynamics; Succession - processes, types; climax concepts.

Unit 7: Ecosystems

(9 Lectures)

Aquatic, terrestrial, manmade (agricultural). Ecosystems of west coast and Western Ghats with special reference to Goa: Wetlands, mangroves, coastal, sand dunes, plateaus and forests.

Unit 8: Functional aspects of ecosystem

(8 Lectures)

Principles and models of energy flow; production and productivity; Ecological efficiencies; Biogeochemical cycles; cycling of carbon, nitrogen and phosphorus.

Unit 9: Phytogeography

(12 Lectures)

Principles: Continental drift; theory of tolerance; Endemism; Brief description of major terrestrial biomes (tropical, temperate and tundra); Phytogeographical division of India; Local vegetation – forest, agriculture.

SUGGESTED READINGS:

1. Odum, E.P. 2005. *Fundamentals of Ecology*. 5th edition. Cengage Learning India Pvt. Ltd., New Delhi.
2. Singh, J.S., Singh, S.P. and Gupta, S. 2006. *Ecology, Environment and Resource Conservation*. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. 2010. *Ecology and Environment*. 8th edition. Rastogi Publication, Meerut, India.
4. Wilkinson, D.M. 2007. *Fundamental Processes in Ecology: An Earth System Approach*. Oxford University Press., U.S.A.
5. Kormondy, E.J. 1996. *Concepts of Ecology*. 4th edition. PHI Learning Pvt. Ltd., Delhi, India.
6. Shukla, R.S. and Chandel P.S. 2014. *A Textbook of Plant Ecology Including Ethnobotany and Soil Science*. 12th edition. S. Chand and Company Limited, New Delhi.