

**SYLLABUS FOR B.Sc. BOTANY (GENERAL & HONOURS) DEGREE PROGRAM UNDER CBCS w.e.f 2017-18**  
**OF SEM-I & II**

**A. B.SC. GENERAL**

**First Year:**

**Semester I:**

BCC – 1: Biodiversity I (Microbes, Algae, Fungi and Bryophytes) (4+2 credits)

**Semester II:**

BCC – 4: Biodiversity II (Vascular plants) (4+2 credits)

**Second Year:**

**Semester III:**

BCC – 7: Plant Anatomy and Embryology (4+2 credits)

**Semester IV:**

BCC – 10: Plant Physiology (4+2 credits)

**B. B.SC. HONOURS**

**First Year:**

**Semester I:**

BCC – 1: Biodiversity I (Microbes, Algae, Fungi and Bryophytes) (4+2 credits)

BCC – 2: Cell Biology (4+2 credits)

BCC – 3: Economic and Medicinal Botany (4+2 credits)

BGE – 1: Environmental Biotechnology (4 credits)

**Semester II:**

BCC – 4: Biodiversity II (Vascular plants) (4+2 credits)

BCC – 5: Plant Biochemistry (4+2 credits)

BCC – 6: Microbiology and Plant Pathology (4+2 credits)

BGE – 2: Coastal and Mangrove Ecology (4 credits)

**Second Year:**

**Semester III:**

BCC – 7: Plant Anatomy and Embryology (4+2 credits)

BCC – 8: Genetics (4+2 credits)

BCC – 9: Plant Systematics (4+2 credits)

BSEC – 1: Floriculture (4+2 credits)

BGE – 3: Plant Diversity and Human Welfare (4 credits)

**Semester IV:**

BCC – 10: Plant Physiology (4+2 credits)

BCC – 11: Molecular Biology (4+2 credits)

BCC – 12: Plant Biotechnology (4+2 credits)

BSEC – 2: Herbal Technology (4+2 credits)

BGE – 4: Mushroom Culture Technology (4 credits)

**Third Year:**

**Semester V:**

BCC – 13: Plant Ecology and Phytogeography (4+2 credits)

BDSE – 1: Analytical Techniques in Plant Sciences (4+2 credits)

BDSE – 2: Research Methodology, bioinformatics and Biostatistics (4+2 credits)

BSEC – 3: Biofertilizers (4+2 credits)

**Semester VI:**

BCC – 14: Plant Breeding and Genetic Engineering (4+2 credits)

BDSE – 3: Horticultural Practices and Post Harvest Technology (4+2 credits)

BDSE – 4: Industrial and Environmental Microbiology (4+2 credits)

BSEC – 4: Nursery and Gardening (4+2 credits)

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**Legend:**

**BCC** = Botany Core Course;

**BDSE** = Botany Discipline Specific Elective;

**BGE** = Botany Generic Elective;

**BSEC** = Botany Skill Enhancement Course.

**BCC - 1: Biodiversity I (Microbes, Algae, Fungi and Bryophytes)**  
**Credits: 4 (Theory): 2 (Practical)**

**THEORY**

**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; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Spirogyra*, *Sargassum*, *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 and classification; True Fungi - General characteristics, ecology and significance with special reference to medicine., life cycle of *Rhizopus* (Zygomycota) *Penicillium*, (Ascomycota), *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

**Unit 4: Bryophytes (15 Lectures)**

General characteristics, Classification, Range of thallus organization. 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*.

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**LABORATORY EXERCISES:**

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle. **(2P)**
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation. **(2P)**
3. Monochrome and Gram staining. **(2P)**
4. Study of vegetative and reproductive structures of *Nostoc*, *Spirogyra*, *Sargassum*, *polysiphonia* through temporary preparations and permanent slides. **(4P)**
5. ***Rhizopus* and *Penicillium***: Asexual stage from temporary mounts and sexual structures through permanent slides. **(2P)**

6. **Agaricus**: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*. **(1P)**
7. **Lichens**: Study of growth forms of lichens (Crustose, foliose and fruticose). **(1P)**
8. **Mycorrhiza**: ectomycorrhiza and endomycorrhiza – (slide preparation/Photographs). **(2P)**
9. **Riccia**: morphology and T. S. of thallus, W. M. rhizoids and scales, V. S. thallus through gemma cup, W. M. gemmae (all permanent slides), V. S. antheridiophore, archegoniophore, L. S. sporophyte (all permanent slides). **(1P)**
10. **Anthoceros**: morphology and T. S. of thallus and sporophyte. Sporophyte (permanent slides). **(1P)**
11. **Funaria**: morphology, W. M. leaf, rhizoids, sporophyte (permanent slides); permanent slides showing antheridial and archegonial heads, L. S. capsule and protonema. **(2P)**
12. Preparation of Jelly, Pudding and Custard using Agar- Agar. **(2P)**
13. Herbarium preparation of algae. **(2P)**
14. Conservation of at least one species of alga and bryophyte in the botanical garden ('Ex-situ' conservation/ Preparation of a Conservatory). **(2P)**
15. Preparation of spawn for Oyster mushroom cultivation. **(2P)**
16. Culturing of *Mucor* and *Aspergillus*. **(2P)**

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#### SUGGESTED READINGS

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
  2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
  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., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4<sup>th</sup> edition.
  5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi.
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**BCC - 2: Cell Biology**  
**Credits: 4 (Theory): 2 (Practical)**

**THEORY**

**Unit 1: Techniques in Biology (10 Lectures)**

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM) - Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; Micrometry; Use of ultracentrifugation.

**Unit 2: Cell as a unit of Life (6 Lectures)**

The Cell Theory; Cell as a unit of structure and function; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components; Origin of eukaryotic cell (Endosymbiotic theory).

**Unit 3: Cell Organelles (24 Lectures)**

**Mitochondria:** Origin of organelles; organelle structure and biogenesis; Structure, marker enzymes, composition; Semi-autonomous nature; Symbiont hypothesis; mitochondrial DNA and function.

**Plastids:** Types of plastids, Chloroplast structure, marker enzymes, composition; semi-autonomous nature, chloroplast DNA and functions.

Structure and functions of Endoplasmic Reticulum (ER), Golgi apparatus, Lysosomes.

**Peroxisomes and Glyoxisomes:** Structures, composition, functions in animals and plants and biogenesis; Cytoskeleton - Structure and role of microtubules, microfilaments and intermediary filament.

**Nucleus:** Nuclear Envelope - structure of nuclear pore complex; nuclear lamina, nuclear matrix, nucleoplasm, nucleosome; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin; DNA, RNA, histones and non-histone proteins; nucleolus and ribosome structure (brief).

**Ribosome:** structure of prokaryotic, eukaryotic and organelle ribosomes; functional significance.

**Unit 4: Cell Membrane and Cell Wall (10 Lectures)**

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Selective permeability of membranes; Role of ion channels and pumps in cellular transport and signaling; endocytosis and exocytosis

**Cell wall:** Ultrastructure, chemical constituents and functions of cell wall.

**Unit 5: Cell Cycle (10 Lectures)**

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

### LABORATORY EXERCISES:

1. Introduction on handling, use and maintenance of microscopes and other laboratory equipments. (2P)
  2. Preparation of stains and staining techniques. (2P)
  3. Study of different mountants (Water, Glycerine, DPX, Lactophenol). (1P)
  4. Measurement of cell size by the technique of micrometry. (2P)
  5. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and Electron micrographs. (2P)
  6. Study of the photomicrographs of cell organelles. (1P)
  7. To study the structure of plant cell through temporary mounts of Onion and *Spirogyra*. (1P)
  8. Study of mitosis and meiosis (temporary mounts and permanent slides). (4P)
  9. Study the effect of temperature, organic solvent on semi permeable membrane. (2P)
  10. Demonstration of dialysis of starch and simple sugar. (1P)
  11. Study of plasmolysis and plasmoptysis on *Rhoeo* leaf. (1P)
  12. Study the structure of nuclear pore complex by photograph (from Gerald Karp). (1P)
  13. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique. (2P)
  14. Histo-chemical test for cellulose, lignin, chitin and suberin in sections. (2P)
  15. Drawings of microscopic objects using camera lucida and photomicrography. (2P)
  16. Study of plastid types using microscope. (1P)
  17. Cell count using haemocytometry and optical density of cell suspension using spectrophotometry. (3P)
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### SUGGESTED READINGS:

1. Alberts, B.; Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co., Inc., New York, USA.
2. Avers, C.J. 1986. Molecular Cell Biology. Addison-Wesley Publishing Co., Massachusetts, USA.
3. 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.
4. Campbell, M.K. 1999. Biochemistry. Saunders College Publishing, Philadelphia, USA.
5. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5<sup>th</sup> edition. ASM Press & Sunderland, Washington, D.C., Sinauer Associates, MA.
6. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8<sup>th</sup> edition. Lippincott Williams and Wilkins, Philadelphia.
7. Gupta, P.K. 1999. A Text Book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
8. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
9. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology, (2<sup>nd</sup> Edition). Harper Collins College Publishers, New York, USA.
10. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology. W.H. Freeman & Co., New York, USA.

11. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemistry (3<sup>rd</sup> Edition). Worth Publishers, New York, USA.
  12. Rawn, D.J. 1989. Biochemistry. Neil Patterson Publishers, North Carolina, USA.
  13. Stryer, L. 1995. Biochemistry. W.H. Freeman & Co., New York, USA.
  14. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.
  15. Zubay, G. 1993. Biochemistry (3<sup>rd</sup> Edition). WCB Publishers, Iowa, USA.
  16. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. Oxford University Press, NY.
  17. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones & Bartlett Publishers, Boston, Massachusetts.
  18. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, UK.
  19. Ninfa, A.J. and Ballou, D.P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.
  20. Wilson, K. and Goulding, K.H. (Eds.). 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.
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**BCC – 3: Economic and Medicinal Botany**  
**Credits: 4 (Theory): 2 (Practical)**

**THEORY**

**Economic Botany**

**Unit 1: Origin of Cultivated Plants (1 Lecture)**

Concept of centres of origin, their importance with reference to Vavilov's work.

**Unit 2: Cereals (3 Lectures)**

Wheat, Rice and Maize - Origin, morphology, cultivation, uses.

**Unit 3: Legumes (3 Lectures)**

General account with special reference to Pea and Gram (Black/green).

**Unit 4: Spices (4 Lectures)**

General account with special reference to clove, black pepper, turmeric, cinnamon, capsicum (Botanical name, family, part used, morphology and uses).

**Unit 5: Beverages (2 Lectures)**

Tea, coffee, cocoa (morphology, processing, uses).

**Unit 6: Oils and Fats (4 Lectures)**

General description with special reference to extraction of groundnut, coconut, sunflower and sesame, and olive oil.

**Unit 7: Fibre Yielding Plants (4 Lectures)**

General description with special reference to Cotton, Jute, Coir, and Agave (Botanical name, family, part used, morphology, extraction, and uses).

**Unit 8: Fruit crops (3 lectures)**

Botanical name, family, part used, morphology and uses of mango, jackfruit, papaya, cashew, pineapple and banana.

**Unit 9: Vegetable crops (3 Lectures)**

Botanical name, family, part used, morphology, cultivation and uses of red amaranth, radish, brinjal, and okhra.

**Unit 10: Timber plants (3 Lectures)**

General description with special reference to matti, sailo, and bamboo.

**Medicinal Botany**

**Unit 11:** Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: Panchamahabhutas, Saptadhatu and Tridosha concepts, Rasayana, plants



used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: Concept: Umoor-e-tabiya, tumors treatments/therapy, polyherbal formulations. **(10 Lectures)**

**Unit 12:** Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: A brief account of plant drugs and their chief constituents used in indigenous and allopathic systems of medicine with regard to: *Hemidesmus indicus*, *Garcinia indica*, *Andrographis paniculata*, *Catharanthus roseus*, *Aloe vera*, *Boerhaavia diffusa*, and *Adathoda vasica*. **(10 Lectures)**

**Unit 13:** Ethnobotany and Folk medicines; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases - Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. **(10 Lectures)**

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#### **LABORATORY EXERCISES:**

1. Identification (botanical name & family), description and utilization of plants and/or plant parts studied in theory, under each group **(15P)**
2. Chemical test for sesame/groundnut oil. **(1P)**
3. T.S. of *Eucalyptus* leaf to study oil glands. **(1P)**
4. Properties of cotton, jute and coir fibres. **(1P)**
5. Study of plants used as sources of drugs (live/herbarium specimens) studied in theory. **(2P)**
6. Extraction of plant pigments (any 2) in water, ethanol and n-hexane: *Curcuma longa* (turmeric), *Bixa orellana* (annato), *Lawsonia inermis* (mehndi) and *Garcinia indica* (Kokum). **(1P)**
7. Vegetative propagation techniques in fruit plants – cutting, grafting, layering and gooty. **(2P)**
8. Preparation of a list of trees, shrubs and herbs (scientific name, common name and brief description) used for worship from different localities. **(2P)**
9. Blood pressure and skin diseases (any one plant or formulation for each disease). **(2P)**
10. Polyherbal formulation for cold (kasai). **(2P)**
11. Extraction of starch from potato. **(1P)**

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#### **SUGGESTED READINGS:**

1. Kochhar, S.L. 2011. Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. - Agrobios, India.
3. Fuller, K.W. and Gallon, J.A. 1985. Plant Products and New Technology. Clarendon Press, Oxford, New York.

4. Nair, M.N.B. 1998. Wood Anatomy and Major Uses of Wood. Faculty of Forestry, Universiti Putra Malaysia, 43400 Serdang, Selangor D. E., Malaysia.
  5. Sambamurthy, A.V.S.S. and Subramanyam, N.S. 1989. A Textbook of Economic Botany. Wiley Eastern Ltd., New Delhi.
  6. Sharma, O.P. 1996. Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi.
  7. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic Botany- Plants in Our World. McGraw Hill, New York.
  8. S. K. Jain. A manual of Ethnobotany. Scientific Publishers (India). Jodhpur.
  9. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
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**BCC - 4: Biodiversity II (Vascular Plants)**  
**Credits: 4 (Theory): 2 (Practical)**

**THEORY**

**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, stelar 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: Introduction to plant taxonomy (4 Lectures)**

Identification, Classification, Nomenclature.

**Unit 4: 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 5: Taxonomic evidences from palynology, cytology, photochemistry and molecular data. (6 Lectures)**

**Unit 6: Taxonomic hierarchy (2 Lectures)**

Ranks, categories and taxonomic groups.

**Unit 7: Botanical nomenclature (6 Lectures)**

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

**Unit 8: Classification (10 Lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series); study of families: Asteraceae, Solanaceae, Lamiaceae, Liliaceae and Poaceae.

**Unit 9: Biometrics, numerical taxonomy and cladistics (4 Lectures)**

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

### LABORATORY EXERCISES:

1. ***Psilotum*** – morphology, W. M. Synangium, T. S. Stem. (2P)
2. ***Selaginella*** - morphology, W. M. leaf with ligule, T. S. stem, W. M. strobilus, W. M. microsporophyll and megasporophyll (temporary slides), L. S. strobilus (permanent slide).(2P)
3. ***Equisetum*** - morphology, T. S. internode, L. S. strobilus, T. S. strobilus, W. M. sporangiophore, W. M. spores (wet and dry) (temporary slides); T. S. rhizome (permanent slide).(2P)
4. ***Pteris*** - morphology, T. S. rachis, V. S. sporophyll, W. M. sporangium, W. M. spores (temporary slides), T. S. rhizome, W. M. prothallus with sex organs and young sporophyte (permanent slide). (2P)
5. ***Cycas*** - morphology (coralloid roots, bulbil, leaf), T. S. coralloid root, T. S. rachis, V. S. leaflet, V. S. microsporophyll, W. M. spores (temporary slides), L. S. ovule, T. S. root (permanent slide). (2P)
6. ***Pinus***- morphology (long and dwarf shoots, W. M. dwarf shoot, male and female), W. M. dwarf shoot, T. S. needle, T. S. stem, , L. S. / T. S. male cone, W. M. microsporophyll, W. M. microspores (temporary slides), L. S. female cone, T. L. S. and R. L. S. stem (permanent slide). (3P)
7. Study of vegetative and floral characters of the following families (Description, V.S.flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker’s system of classification): Asteraceae, Solanaceae, Lamiaceae, Liliaceae and Poaceae (Any two locally available plants per family). (10P)
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book). (2P)
9. Field Botany. (5P)

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### SUGGESTED READINGS:

1. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India.
  2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, 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. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.
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**BCC - 5: PLANT BIOCHEMISTRY**  
**Credits: 4 (Theory): 2 (Practical)**

**THEORY**

**Unit 1: Cellular chemistry:** Molecular interactions; chemical bonds (primary and secondary) and their significance; peptide and disulphide bonds. Structure, properties and biological importance of water. pH, biological buffers and their significance. **(7 Lectures)**

**Unit 2: Carbohydrates:** Classification, properties and structure of monosaccharides; disaccharides; oligosaccharides and polysaccharides with one example each; biological role of carbohydrates. Synthesis and degradation of sucrose and starch in plants. **(7 Lectures)**

**Unit 3: Lipids:** Classification, properties and biological role of lipids; structure and functions of fatty acids. Synthesis and breakdown of triglycerides;  $\beta$ -oxidation. **(6 Lectures)**

**Unit 4: Amino acids:** Classification, structure and properties of amino acids; essential & non-essential amino acids; transamination; biological role of amino acids. **(4 Lectures)**

**Unit 5: Proteins:** Classification, properties and structure (primary, secondary, tertiary & quaternary) of proteins; denaturation and renaturation of proteins; biological role of proteins. **(6 Lectures)**

**Unit 6: Nucleic acids:** Structure of components of nucleic acids (nitrogen bases, nucleosides and nucleotides). Types of nucleic acids (DNA & RNA); structure of B-DNA; characteristics of other forms of DNA (A, C, D and Z). Types of RNA, structure of tRNA, role of RNA in protein synthesis. **(6 Lectures)**

**Unit 7: Vitamins:** Broad classification of vitamins; properties, structure, functions and deficiency symptoms of vitamins A, B complex, C, D, E, P and K. **(5 Lectures)**

**Unit 8: Bioenergetics:** Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions and redox reactions. ATP - the energy currency molecule. **(5 Lectures)**

**Unit 9: Enzymes:** Nomenclature, classification and importance of enzymes; physico-chemical properties; structure of enzyme molecule; isoenzymes; mechanism of enzyme action (lock and key hypothesis & induced-fit theory); Michaelis-Menten equation; enzyme specificity; enzyme inhibition; factors affecting enzyme activity. **(10 Lectures)**

**Unit 10: Secondary metabolites:** Broad classification of secondary metabolites; properties and functions of terpenoids, alkaloids, flavonoids. **(4 Lectures)**

**LABORATORY EXERCISES:**

1. Preparation of reagents (molar and normal solutions) (calculations). (1P)
  2. Preparation of buffers (calculations). (1P)
  3. Measurement of pH of C<sub>3</sub>, C<sub>4</sub> and CAM plant extracts. (1P)
  4. Qualitative tests for biomolecules (carbohydrates, fats, amino acids and proteins). (4P)
  5. Micro-chemical detection of reducing sugars in floral nectar using Benedict's Reagent. (1P)
  6. Verification of Beer Lambert Law (Conc. v/s O.D.) (1P)
  7. Estimation of reducing sugars by DNSA method. (2P)
  8. Determination of acid value of fat. (1P)
  9. Estimation of proteins using Lowry's method. (2P)
  10. Estimation of proteins using Biuret method. (2P)
  11. Estimation of ascorbic acid. (1P)
  12. Study of amylase activity (effect of substrate concentration, enzyme concentration, pH, temperature – any 3). (3P)
  13. Study of lipase activity in germinating groundnut seeds. (1P)
  14. Separation of amino acids by TLC. (2P)
  15. Separation of photosynthetic pigments by paper chromatography. (2P)
  16. Estimation of DNA using Di-phenyl amine method. (1P)
  17. Estimation of RNA using Orcinol method. (1P)
  18. Localization of carbohydrates using PAS. (1P)
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**SUGGESTED READINGS:**

1. Campbell MK (2012). Biochemistry, 7<sup>th</sup> edition, Published by Cengage Learning.
2. Campbell PN and Smith AD (2011) Biochemistry Illustrated, 4<sup>th</sup> edition, Published by Churchill Livingstone
3. Verma SK and Verma M (2007). A textbook of Plant Physiology, Biochemistry and Biotechnology, 6<sup>th</sup> edition, Published by S. Chand and Company Ltd., New Delhi.
4. Jain JL, Jain S and Jain N (2007). Elementary Biochemistry, 3<sup>rd</sup> edition, Published by S. Chand and Company Ltd., New Delhi.
5. Tymoczko JL, Berg JM and Stryer L (2012). Biochemistry: A short course, 2<sup>nd</sup> edition, Published by W. H. Freeman.
6. Boyer R (2001). Modern Experimental Biochemistry, 3<sup>rd</sup> edition, Published by Pearson Education, Singapore.
7. Mathur R and Mehta M (2002). Biochemistry, 1<sup>st</sup> edition, Published by J L Kumar for Anmol Publications Pvt. Ltd., New Delhi.
8. Berg JM, Tymoczko JL and Stryer L (2011). Biochemistry, Published by W.H. Freeman and Company.
9. Nelson DL and Cox MM (2008). Lehninger Principles of Biochemistry, 5<sup>th</sup> edition, W. H Freeman and Company.
10. Hopkins WG and Huner A (2008). Introduction to Plant Physiology, 4<sup>th</sup> edition, John Wiley and Sons, U.S.A.
11. Taiz L, Zeiger E, Møller IM and Murphy A (2015). Plant Physiology and Development. 6<sup>th</sup> edition, Sinauer Associates Inc. USA.

12. Harborne JB (1973). *Phytochemical Methods*, John Wiley & Sons, New York.
  13. Stryer L (1995). *Biochemistry*, W. H. Freeman and Co., New York, USA.
  14. Sadasivam S and Manickam A (1996). *Biochemical Methods*, New Age International Publishers.
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## BCC 6: MICROBIOLOGY AND PLANT PATHOLOGY

Credits: 4 (Theory): 2 (Practical)

### THEORY

#### A. Microbiology:

**Unit 1: Discovery of microorganisms:** Miller's experiment; characteristic features of different groups of microorganisms; broad classification of bacteria based on *Bergey's Manual*. (3 Lectures)

**Unit 2: Ultrastructure of microorganisms:** Viruses (properties, classification - ICTV & Baltimore, replication); ultrastructure of prokaryotic cell (bacterial cell) and eukaryotic cell (plant cell); characteristics of prions, viroids, mycoplasma, actinomycetes, T<sub>4</sub> bacteriophage, and yeasts. (8 Lectures)

**Unit 3: Methods in microbiology:** Staining methods (simple, differential and special staining); methods of sterilization (physical and chemical); types of culture media; pure culture methods (streak plate, spread plate and pour plate); bacterial motility; methods for enumeration (direct and indirect); bacterial growth curve. (8 Lectures)

**Unit 4: Preservation and maintenance of microbial cultures:** Methods of preservation (periodic transfer, use of mineral oil and liquid nitrogen, lyophilisation); culture collection centres (culture banks) and their importance. (4 Lectures)

**Unit 5: Microbial interactions and biogeochemical cycling of elements:** Microorganisms associated with the plant roots and symbiotic nitrogen fixation; biofertilizers and their role in agriculture; mycorrhizae and their role in agriculture and forestry; plant microbe interaction in bioremediation. Biogeochemical cycling of nitrogen, phosphorus and carbon. (7 Lectures)

#### B. Plant Pathology:

**Unit 6: General account of plant pathogens:** General account of diseases caused by plant pathogens; symptomatology; identification of plant disease – Koch's postulates. (3 Lectures)

**Unit 7: Pathogen attack and defence mechanisms:** Stages of disease establishment; structural and biochemical defence mechanisms. (5 Lectures)

**Unit 8: Plant disease epidemiology:** Transmission and spread of plant pathogens; disease cycles, plant disease epidemics. (4 Lectures)

**Unit 9: Plant disease management:** Cultural, physical, chemical, biological and IPM systems; development of transgenics for disease management; biopesticides; plant disease clinics. (8 Lectures)



**Unit 10: Genetics of resistance and susceptibility:** Genes for virulence and avirulence, their application in resistance and susceptibility. **(3 Lectures)**

**Unit 11: Molecular plant pathology:** Molecular diagnosis; identification of genes and specific molecules in disease development (DNA and protein based diagnostic kits). **(4 Lectures)**

**Unit 12: Application of Information Technology in plant pathology:** Computer simulation of epidemics and disease forecasting; use of remote sensing and image analysis in plant pathology. **(3 Lectures)**

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#### **LABORATORY EXERCISES:**

1. Introduction to microbiology laboratory, concept of sterilization, working and handling of laboratory equipments. **(2P)**
  2. Introduction to biosafety and biohazards in laboratory. **(1P)**
  3. Determination of microbial population (yeast) size by serial dilution technique. **(1P)**
  4. Preparation of liquid and solid (plates and slants) culture media – nutrient broth, nutrient agar and PDA. **(3P)**
  5. Isolation of microorganisms from air; study of colony characteristics and preparation of pure culture by streak plate method (plates and slants). **(2P)**
  6. Colony characteristics of bacteria and fungi in pure culture. **(2P)**
  7. Study of bacterial motility by hanging drop method. **(1P)**
  8. Turbidimetric determination of growth of a microorganism using spectrophotometer (*E. coli*/yeast). **(2P)**
  9. Screening for amylase producing microorganisms from soil using starch agar by serial dilution-spread plate method. **(2P)**
  10. Screening for antimicrobial activity of plant extracts by agar well diffusion/agar disc method (extracts of neem, garlic and lemon grass; positive and negative control). **(2P)**
  11. Isolation of AM spores from rhizosphere soil. **(2P)**
  12. Study of symptoms, disease cycle and control measures of plant diseases (viral, bacterial and fungal – one each). **(1P)**
  13. Anatomy/mounting of spores from fungus infected specimens (rust, blight & rot). **(1P)**
  14. Demonstration of Koch's postulates for a bacterial/fungal pathogen. **(3P)**
  15. Field Plant Pathology (Collection and identification of local crop diseases). **(5P)**
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#### **SUGGESTED READING**

1. Agrios, G.N. 1997. Plant Pathology. Academic Press, London.
2. Albajes, R., Gullino, M.L., van Lenteren, J.C. and Elad, Y. 2000. Integrated Pest and Disease Management in Greenhouse Crops. Kluwer Academic Publishers.
3. Aneja, K. R. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Publication, New Delhi.
4. Bridge, P. et al. 1998. Molecular Variability of Fungal Pathogens. CAB International, UK.
5. Bridge, P. et al. 1999. Application of PCR in Mycology. CAB International, UK.

6. Bridge, P., Moore, D.R. and Scott, P.R. 1998. Informationa.i Technology, Plant Pathology and Biodiversity. CAB International, UK.
  7. Eklund, C. and Lankford, C.WE. 1967. Laboratory Manual for General Microbiology. Prentice-Hall, Inc., Engle-wood Cliffs, N.J.
  8. Gunasekaran, P. 1995. Laboratory Manual in Microbiology. New Age International Pvt. Ltd.
  9. Mahadevan, A. and Sridhar, R. 1986. Methods in Physiological Plant Pathology. Sivakami Publication, Madras.
  10. Meyneil, E. and Meynell, G.G. 1970. Theory and Practice in Experimental Bacteriology. University Press, Cambridge.
  11. Pawsey, R.K. 1974. Techniques with Bacteria - A Guidebook for Teachers. Hutchinson Educational.
  12. Pelezar, M.J. and Chan, E.C.S. 1972. Laboratory Exercises in Microbiology. McGraw Hill Book Co.
  13. Persley, G.J. 1996. Biotechnologies and Integrated Pest Management. CAB International, UK.
  14. Schaad, N. W. 1988. Plant Pathogenic Bacteria: Laboratory Guide for Identification of Plant Pathogenic Bacteria. Academic Press.
  15. Skerritt, J.H. and Apples, R. 1995. New Diagnostics in Crop Sciences. CAB International, UK.
  16. Sullia, S.B. 2001. General Microbiology, Oxford Publishers, New Delhi.
  17. Tauro, P.T. 1988. Introductory Microbiology.
  18. Vaidya, J.C. 2000. Biology of Fungi.
  19. Wistreich, G.A. and Lechtman, M.D. 1973. Laboratory Exercises in Microbiology. Glencoe Press, New York, Beverly Hills, Collier Macmillan Publishers, London.
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**BGE 1 - Environmental Biotechnology**  
**(Credits: Theory-4)**  
**Lectures: 60**

**THEORY**

**Unit 1: Environment (4 lectures)**

Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.

**Unit 2: Environmental problems (6 lectures)**

Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.

**Unit 3: Microbiology of waste water treatment (8 lectures)**

Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries.

**Unit 4: Xenobiotic compounds (10 lectures)**

Organic (chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, decay behaviour and degradative plasmids, molecular techniques in bioremediation.

**Unit 5: Role of immobilized cells/enzymes in treatment of toxic compounds (6 lectures)**

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control.

**Unit 6: Sustainable Development (8 lectures)**

Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics.

**Unit 8: International and National Legislations, Policies for Pollution Management (10 lectures)**

Stockholm Conference (1972) and its declaration, Ramsar Convention 1971, Kyoto Protocol-1997, Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act-1974, Forest conservation act 1980, Air Pollution (Prevention and Control) Act-1981,

National Environmental Policy -2006, Central and State Pollution Control Boards: Constitution and Power.

**Unit 9: Public Participation for Environmental Protection (8 lectures)**

Environmental movement and people's participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and Environmental Protection, Role of NGO in bringing environmental awareness and education in the society.

**Suggested Readings**

1. Waste Water Engineering - Treatment, Disposal and Reuse (1991) Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.
  2. De, A. K. (1994) Environmental Chemistry, Wiley Eastern Ltd, New Delhi.
  3. Allsopp, D. and Seal, K. J. (2004) Introduction to Biodeterioration, ELBS / Edward Arnold.
  4. Baaker, K. H. and Herson D.S. (1994) Bioremediation, Mc.GrawHill Inc, NewYork.
  5. Ahmed, N., Qureshi E. M. and Khan, O. Y. (2006) Industrial and Environmental Biotechnology. Horizon Press.
  6. Paul. A, R. (2001) Environmental Molecular Biology. Horizon Press.
  7. Jadhav, H. V. and Bhosale, V.M. (1997) Environmental Protection and Laws Himalaya publication House 13.
  8. Trivedi, P. C. (2006) Biodiversity Assessment and Conservation. Agrobios, India.
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**BGE 2 - Coastal and Mangrove Ecology**  
**(Credits: Theory-4)**  
**Lectures: 60**

**Unit 1 – Principles of coastal ecology:** Sand dunes with emphasis on vegetation and ecological importance, mangrove biodiversity - Inter-relationships between ecosystems - Methods of assessing biodiversity - Importance of assessing species diversity and status - IUCN conservation species status - Status book. **(6 Lectures)**

**Unit 2 - Distribution of Mangroves:** Global distribution, Extent of mangroves in various countries - Past and present extent of distribution, damage and reclamation caused in the recent past. **(3 Lectures)**

**Unit 3 - Biology of Mangroves:** Taxonomy and genetics - Temporal and regional variations - Morphology and anatomy - temporal and regional variations; Physiology and biochemistry - Factors affecting various growth parameters. Pollination biology - Types of reproduction, seed propagation, dispersal and establishment. Ecological and environmental conditions that affect mangrove ecosystems **(15 Lectures)**

**Unit 4 - Flora and fauna of Mangroves and Associated Environments:** Bacteria, fungi and actinomycetes, microalgae, sea-grasses, salt-marsh and other flora - Collection, preservation and identification techniques - Factors Affecting biodiversity - Comparison of flora of mangroves and associated environments; general account of mangrove fauna. **(8 Lectures)**

**Unit 5 - Ecological roles of Mangroves:** Litter production and decomposition and nutrient enrichment; biomass, food web and energy fluxes; interaction of mangroves with other halophytes and agro-ecosystems; Importance - Damages caused - Need for conservation. **(8 Lectures)**

**Unit 6 - Threat Factors Affecting Mangrove Systems:** Water quality parameters, Anthropogenic pressure, Types of pollutants causing damage to mangroves - Sewage, industrial, and other organic and inorganic man-made pollutants, Extent of damage, Possible remedial measures. **(8 Lectures)**

**Unit 7 - Conservation and Management Strategies Restoration Technology –** Species selection, Propagation and plantation techniques; Conservation strategies. **(8 Lectures)**

**Unit 8 – Advanced concepts to be learnt under teachers supervision by study visit to NIO. (4 Lectures)**

**Reference Books:**

1. Chapman V.J. and Chapman D. J. (1975) *The Algae*, 2nd Edition, MacMillan Publications Inc. New York.
  2. Lembi, C.A. and Waaland, J. R. (1988) *Algae and Human Affairs*. Press Syndicate of the University of Cambridge.
  3. Lobban, C.S., Harrison, P. J. And Duncan, M. J. (1985). *The Physiological ecology of Seaweeds*. Cambridge University Press, New York.
  4. Roy, P.M. and Helfferich C. (1997) *Seagrass Ecosystems*, Maxel Dekker II, New York.
  5. Borse D. G. and D. J. Bhat (2012) *Marine Fungi of India*. BBC Publishers.
  6. Websites of NIO and Mangrove Society of India.
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