

HIMACHAL PRADESH UNIVERSITY SHIMLA-171005

CHOICE BASED CREDIT SYSTEM (CBCS) IN BOTANY

CBCS Programme for B.Sc. with Botany (Major) w.e.f. June 2013

SEMESTER-I

Code: BSCBOT0101

Phycology, Mycology and Plant Pathology

Credits = 3

Course duration- 40Hours

UNIT-I (Phycology)

Subunit-A: General characters, classification up to families (Fritsch 1945) and economic importance. _____ **02 Hours**

Subunit-B: Important features and life history (excluding development) of *Nostoc* (Cyanophyceae), *Volvox*, *Oedogonium* (Chlorophyceae), *Vaucheria* (Xanthophyceae), Diatoms (Bacillariophyceae), *Ectocarpus* (Phaeophyceae) and *Polysiphonia* (Rhodophyceae). Pigment constitution of the above mentioned classes. _____ **12 Hours**

UNIT-II (Mycology)

Subunit-C: General characters, classification up to families (Alexopoulos and Mims 1979) and economic importance. _____ **03 Hour**

Subunit-D: Important features and life history (excluding development) of *Phytophthora*, *Albugo* (Mastigomycotina) *Rhizopus* (Zygomycotina), *Saccharomyces*, *Penicillium*, *Neurospora* (Ascomycotina), *Puccinia*, *Agaricus* (Basidiomycotina) and *Colletotrichum* (Deuteromycotina). _____ **13 Hour**

Subunit-E: Lichens (Lichen components and their nature of association; Occurrence; Classification by Hole 1967; Morphology and anatomy of thallus; Special vegetative structures associated with lichen thallus; Reproduction; Ecological and Economic importance). _____ **03 Hours**

UNIT- III (Plant Pathology)

Subunit-F: Definitions, symptoms, classification and etiology of following diseases: White rust of crucifers, Late blight of potato, Apple scab, Loose smut of wheat, Black stem rust of wheat, Early blight of potato, Red rot of sugarcane and Citrus canker; General account of plant disease control (Quarantine, Chemical, Biological and Integrated); losses caused by plant diseases. _____ *07 Hours*

PRACTICAL

Code: BSCBOT 0101(P)

Phycology, Mycology & Plant Pathology

Credit = 1

1. Study of some laboratory techniques (Whole mounts, Maceration, Smearing, Section cutting, Squash, Light microscopy, Digital image projection and Micrometry).
2. Preparation of Fixing agents (Carnoy's fluid, Formalin-Aceto-Alcohol), Stains (Acetocarmine, Aniline blue, Crystal violet, Fast green, Safranin, Gram's iodine); Grades of Ethanol, Clearing agents and Mounting media (Glycerine jelly, Lactophenol, DPX and Canada balsam).
3. Preparation of Temporary stained mounts of type specimens (Whole mounts, teased mount) as mentioned in theory paper.

Suggested Readings

- **Phycology:**
 - a. Kumar, H.D. and Singh, H.N. 1995. A Text book on Algae. Affiliated East West Press Pvt. Ltd., New Delhi.
 - b. Kumar, H.D. 1988. Introductory Phycology. Affiliated East West Press Pvt. Ltd., New Delhi.
 - c. Vashistha, B.R., Sinha, A.K. and Kumar, A. 2010. Botany for Degree Students- Algae. S.Chand & Co. Ltd.
 - d. Bendre, A. and Kumar, A. 2012. A Textbook of Practical Botany. Vol. I. Rastogi Publications.
 - e. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
- **Mycology:**
 - a. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. John Wiley and Sons, Inc.
 - b. Bendre, A. and Kumar, A. 2012. A Textbook of Practical Botany. Vol. I. Rastogi Publications.
 - c. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.

- d. Mehrotra, R.S. and Aneja, R.S. 1998. An Introduction to Mycology. New Age Intermediate Press.
 - e. Sharma, P.D. 2004. Fungi. Rastogi publications.
 - f. Sharma, P.D. 2005. Fungi and Allied organisms. Alpha science Intl. Ltd.
 - g. Vashistha, B.R. and Sinha, A.K. 2010. Botany for Degree Students-Fungi. S.Chand& Co. Ltd.
 - h. Webster, J. and Weber, R.W.S. 2007. Introduction to Fungi. Cambridge University Press.
- **Plant Pathology:**
 - a. Agrios, G.N. 2005. Plant Pathology. Elsevier Academic Press
 - b. Bendre, A. and Kumar, A. 2012. A Textbook of Practical Botany. Vol. I. Rastogi Publications.
 - c. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
 - d. Pandey, B.P. 2001. Plant Pathology-Pathogen and Plant Disease. S.Chand& Co. Ltd.
 - e. Rangaswamy, G. and Mahadevan, A. 1999. Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd., New Delhi.

Code: BSCBOT0102

Bryophyta and Pteridophyta

Credits = 3

Course duration- 40Hours

UNIT- I (Bryophyta)

Subunit-A: General characters, classification up to families (Proskauer 1957); Economic and Ecological importance. _____ **04 Hours**

Subunit-B: Morphology, anatomy, reproduction (excluding development) and life history of *Marchantia*, *Porella*, *Anthoceros*, *Sphagnum* and *Funaria*. _____ **15 Hours**

UNIT- II (Pteridophyta)

Subunit-C: General characters, classification upto families (Sporne1975); Evolution of stele; Brief account of Apogamy and Apospory; Study of fossil plant *Rhynia*. _____ **06 Hours**

Subunit-D: Morphology, anatomy, reproduction (excluding development) and life history of *Psilotum*, *Selaginella*, *Equisetum*, *Adiantum* and *Marsilea*. _____ **15 Hours**

PRACTICAL

Code: BSCBOT 0102(P)

Bryophyta & Pteridophyta

Credit = 1

1. Study of morphology, anatomy and reproduction of type specimens as mentioned in theory paper.
2. Section cutting procedure of Bryophyta and Pteridophyta specimens.
3. Preparation of Double stained permanent mount of Pteridophyta sections.

Suggested Readings

01. Bryophyta:

- a. Bendre, A. and Kumar, A. 2012. A Textbook of Practical Botany. Vol. I. Rastogi Publications.
- b. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
- c. Parihar, N.S. 1991. Bryophyta. Central Book Depot. Allahabad.
- d. Puri, P. 1980. Bryophyta. Atma Ram & Sons. Delhi.
- e. Rashid, A. 1998. An Introduction to Bryophyta. VikasPublishing HousePvt. Ltd. New Delhi.
- f. Vashistha, B.R., Sinha, A.K. and Kumar, A. 2012. Botany for Degree Students-Bryophyta. S.Chand& Co. Ltd.

02. Pteridophyta:

- a. Rashid, A. 1999. An Introduction to Pteridophyta. VikasPublishing HousePvt. Ltd. New Delhi.
 - b. Bendre, A. and Kumar, A. 2012. A Textbook of Practical Botany. Vol. I. Rastogi Publications.
 - c. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
 - d. Parihar, N.S. 1996. Pteridophyta. Central Book Depot. Allahabad.
 - e. Sporne, K.R. 1991. The Morphology of Pteridophytes. B.I Publishing Pvt. Ltd. Bombay.
 - f. Vashistha, P.C., Sinha, A.K. and Kumar, A. 2010. Botany for Degree Students-Pteridophyta. S.Chand & Co. Ltd.
-

Semester-II

Code: BSCBOT0203

Palaeobotany and Gymnosperms

Credits = 3

Course duration- 40Hours

UNIT- I (Palaeobotany)

Subunit-A: Fossils and fossilization process; Type of fossils and their importance; Contribution of Prof. (Dr.) Birbal Sahni. _____ **09 Hours**

Subunit-B: Reconstruction of fossil plant *Lyginopteris*; Geological Time Table (Up to period level with characteristic plant life); Evolution of seed habit. _____ **09 Hours**

UNIT-II (Gymnosperms)

Subunit-C: General characters, Classification up to families (Pilger and Melchior's 1954); Economic importance. _____ **05 Hours**

Subunit-D: Morphology, anatomy, reproduction and life history of *Cycas*, *Pinus*, and *Ephedra*. _____ **17 Hours**

- a. *Teacher is supposed to prevent students, collecting any type of plants and submitting them in the form of Herbarium for the practical examination, as this practice is destroying the flora and fauna. Instead, the students should be asked to prepare field reports.*
- b. *Teacher should accompany the students for field visit (College campus, local visit, college education tour to Botanical garden).*
- c. *Field visit is ESSENTIAL PART OF THE COURSE.*

PRACTICAL

Code: BSCBOT 0203(P)

Palaeobotany & Gymnosperms

Credit = 1

1. Study of morphology, anatomy and reproduction of type specimens as mentioned in theory paper.
2. Preparation of Double stained permanent mount of Gymnosperm sections.
3. Study of Palaeobotany using models, images or rock specimens.

Suggested Readings

01. Palaeobotany:

- a. Srivastava, H.N. 2000. Palaeobotany. Pradeep Publications.
- b. Stewart, W.N. and Rathwell G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press.

02. Gymnosperms:

- a. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
- b. Bhatnagar, S.P and Moitra, A. 1996. Gymnosperms. New Age International Pvt. Ltd. Publishers, New Delhi.
- c. Sporne, K.R. 1965. The Morphology of Gymnosperms. Hutchinson 7 Co. Ltd., London.

Code: BSCBOT0204

Plant Taxonomy and Selected Families of Angiosperms

Credits = 3

Course duration- 40Hours

UNIT- I (Plant Taxonomy)

Subunit-A: Angiosperms origin and evolution; Taxonomy and Systematics; Aim of taxonomy; Functional components of taxonomy (Alpha, Beta and Omega taxonomy).

____ **02 Hours**

Subunit-B: Binomial nomenclature, principles and rules; Principle of priority; Role of Chemotaxonomy, Cytotaxonomy and Taxometrics in relation to taxonomy; Type concept and keys to identification of plants; Basic idea of Herbarium preparation and its significance; Botanical gardens and their role (Royal Botanic Garden, Kew England, Indian Botanic Garden, Calcutta and National Botanic Garden, Lucknow). ____ **08 Hours**

Subunit-C: Differences among Artificial, Natural and Phylogentic system of classification; Phylogenetic (Evolutionary) principles; Salient features of the systems of classification of Angiosperms proposed by Bentham & Hooker and Engler & Prantl. ____ **05 Hours**

UNIT-II

(Selected Families of Angiosperms)

Subunit-D: Floral terminology and type of inflorescence. ____ **03 Hours**

Subunit-E: Floral diversity, diagnostic features and economic importance of following families:

01. Ranunculaceae(*Ranunculus*)

02. Brassicaceae / Cruciferae(*Brassica*)

03. Malvaceae(*Hibiscus*)

04. Rutaceae(*Citrus*)

05. Fabaceae / Leguminosae(**Caesalpinioideae: *Cassia*; Faboideae: *Pisum*; Mimosoideae: *Acacia***)

06. Rosaceae(*Rosa*)

07. Cucurbitaceae(*Cucurbita*)

08. Apiaceae / Umbelliferae (*Coriandrum*)

09. Asteraceae / Compositae(*Helianthus*)

10. Asclepiadaceae(*Calotropis*)

11. Apocyanaceae (*Vinca*)

12. Solanaceae (*Solanum*)

13. Lamiaceae / Labiatae(*Salvia*)

14. Chenopodiaceae(*Chenopodium*)

15. Euphorbiaceae(*Euphorbia*)

16. Liliaceae(*Allium*)

17. Poaceae / Gramineae(*Triticum*)

18. Orchidaceae(*Zeuxine*)_____22 Hours

Note to Teachers:

1. Teacher will demonstrate the methodology of Herbarium preparation.

2. Teacher is supposed to prevent students, collecting any type of plants and submitting them in the form of Herbarium for the practical examination, as this practice is destroying the flora and fauna. Instead, the students should be asked to prepare field reports.

3. Teacher should accompany the students for field visit (College campus, local visit, college education tour to Botanical garden).

4. Field visit is ESSENTIAL PART OF THE COURSE.

PRACTICAL

Code: BSCBOT 0204(P)

Plant Taxonomy and Selected Families of Angiosperms

Credit = 1

1. Study of root , stem and leaf morphology.
2. Study of inflorescence.
3. Botanical description of flowers as specified in the theory paper.

Suggested Readings

- **Plant Taxonomy and Selected Families of Angiosperms:**
 - a. Chopra, G.L. 2001. Angiosperms. Pradeep Publications.
 - b. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
 - c. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperms Taxonomy. Oliver and Boyd. London.
 - d. Heywood, V.H. and Moore, D.M. (eds) 1984. Current concepts in Plant Taxonomy. Academic Press. London.
 - e. Jeffery, C. 1982. An introduction to Plant Taxonomy. Cambridge University Press. Cambridge.
 - f. Jones, S.B. and jr.Luchsinger, A. E. 1986. Plant Systematics. McGraw-Hill Book Co. New York.
 - g. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw-Hill Company Ltd.
 - h. Sharma, O.P. 1993. Plant Taxonomy. Tata McGraw-Hill Company Ltd.

- i. Singh, G. 1999. Plant Systematics: Theory and Practical. Oxford and IBH Pvt. Ltd., New Delhi.
- j. Sinha, R.K. 2010. Practical Taxonomy of Angiosperms. I.K. International Publishing House Ltd.
- k. Stace, C. A.1989. Plant Taxonomy and Biosystematics. Edward Arnold. London.
- l. Subrahmanyam, N.S. Modern Plant Taxonomy. 1995. Vikas Publishing House Pvt . Ltd.

Semester-III

Code:BSCBOT0305

Economic Botany and Plant Anatomy

Credits = 3

Course duration- 40Hours

UNIT- I (Economic Botany)

Subunit-A: Brief account about the centres of origin of major economic crops (Rice, Wheat, Maize, Potato, Sugarcane, Mustard, Cotton and Rubber); Knowledge about location of National and International agricultural research centres or institutes of Rice, Wheat, Maize and Potato. _____ **03 Hours**

Subunit-B:Distribution, botanical description and brief idea of cultivation and uses of the following:

Cereals: Rice, Wheat and Maize. **Vegetables:** Potato. **Fibres:** Cotton and Jute. **Oils:** Mustard, Groundnut, Sunflower and Coconut. **Medicinal plants:** Opium, *Rauwolfia*, *Cinchona* and *Cannabis*. **Beverages:** Tea and Coffee. **Rubber:** *Hevea*. **Sugar:** Sugarcane. _____ **15 Hours**

Subunit-C: Spices (Listing of common spices, their Botanical names, families and part used); Timber yielding plants of India with emphasis on Himachal Pradesh (Write only the Botanical names, families, occurrence and few words about wood properties). _____ **04 Hours**

UNIT- II (Plant Anatomy)

Subunit-D: Diversity in plant forms-annuals, biennials and perennials; Meristematic and permanent tissues (simple and complex). _____ **03 Hours**

Subunit-E (The Shoot System): Shoot apical meristem and theories about its histological organizations (Monocot and Dicot); Structure of primary monocot (Maize) and dicot stem (Sunflower); Secondary growth in dicot stem; Cambium structure and functions; Characteristics of growth rings; Sap wood and heart wood; Periderm; Anomalous secondary growth with reference to *Dracaena* and *Boerhaavia*. _____ **05 Hours**

Subunit-F (Leaf): Type of leaves; Phyllotaxy and venation pattern; Anatomy of typical Monocot (Grass / Maize) and Dicot leaf (Sunflower); Examples of cell inclusions in leaves; Stomatal apparatus and their morphological types. _____ **05 Hours**

Subunit-G (The Root System): Root apical meristem and theories about histological organization (Monocot and Dicot); Secondary growth in dicot root; Structural modifications in roots with reference to *Beta* (storage), *Rhizophora* (respiratory), *Vanda* (epiphytic) and root nodules of Leguminous plant (Interaction with microbes). _____ **05 Hours**

PRACTICAL

Code: BSCBOT 0305(P)

Economic Botany & Plant Anatomy

Credit = 1

1. Study of Economic Botany specimens as mentioned in theory paper.
2. Anatomy of Angiosperms as mentioned in theory paper.
3. Section cutting and preparation of double stained permanent mounts.

Suggested Readings

01. Economic Botany:

- a. Kocchar, S.L. 1998. Economic Botany in the Tropics. McMillan India Ltd., New Delhi.
- b. Sharma, O.P. 1996. Hills Economic Botany (Late Dr. A.F. Hill adapted by Sharma, O.P.1996), Tata McGraw-Hill Co. Ltd., New Delhi.
- c. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic Botany-Plants in our World. McGraw-Hill. New York.

02. Plant Anatomy:

- a. Bendre, A. and Kumar, A. 2009. A Textbook of Practical Botany. Vol. II. Rastogi Publications.
- b. Cutler, D.F., Botha, T. and Stevenson, D.W. 2007. Plant Anatomy (an applied approach). Blackwell Publishing.
- c. Eames, A. J. and MacDaniels, L.H. 1972. An Introduction to Plant Anatomy. Tata McGraw-Hill Co. Ltd., New Delhi.
- d. Esau, K. 1977. Anatomy of Seed Plants. John Wiley & Sons, Inc.
- e. Evert, F.R. 2006. Esau's Plant Anatomy. John Wiley & Sons, Inc.
- f. Fahn, A. 1974. Plant Anatomy. Pergamon Press, Oxford.

- g. Pandey, B.P. 2001. Plant Anatomy. S.Chand& Co. Ltd.
 h. Rudall, P.J. 2007. Anatomy of Flowering Plants (an introduction to structure and development). Cambridge University Press.

Code: BSCBOT0306

Embryology of Angiosperms

Credits = 3

Course duration- 40Hours

UNIT- I

Subunit-A: Contribution of Prof.(Dr.) Panchanan Maheshwari; Flower a modified shoot; Functions of various floral parts._____ **05 Hours**

Subunit-B: Microsporangium, its wall and dehiscence mechanism; Microsporogenesis, pollen grains and detailed account of its structure ; Pollen aperture type and NPC system; Pollination (types and agencies); Pollen-pistil interaction; Self incompatibility; Pollen germination and development of male gametophyte._____ **12 Hours**

UNIT-II

Subunit-C: Structure of Megasporangium (Ovule); Megasporogenesis and Megagametogenesis(Development of female gametophyte); Examples of female gametophyte (Monosporic, bisporic and tetrasporic); Double fertilization; Endosperm types and its biological importance; Embryogenesis in dicot (*Capsella*) and monocot (*Sagittaria*); Polyembryony; Apomixis (Vegetative reproduction and Agamospermy._____ **17 Hours**

Subunit-D: Structure of dicot and monocot seed; Fruit types; Dispersal mechanism in fruits and seeds._____ **06 Hours**

PRACTICAL

Code: BSCBOT 0306(P)

Embryology of Angiosperms

Credit = 1

1. Morphological and Anatomical study of floral parts.
2. Study of pollination behaviour.
3. Morphological study of fruit, seed and their dispersal mechanisms.
4. Study of monocot , dicot embryo and testing their viability by NTC test.

Suggested Readings

- **Embryology of Angiosperms:**

Bhojwani, S.S. and Bhatnagar, S.P.1999. The Embryology of Angiosperms. Vikas Publishing House, Delhi.

Semester-IV

Code: BSCBOT0407

Cytogenetics

Credits = 3

Course duration- 40Hours

UNIT-I

Subunit-A (Mendelian Genetics): Biography of Gregor Johann Mendel; Mendel's experiments on garden pea; Laws of dominance, Segregation, and Independent assortment; Modern genetic terminology. _____ **5Hours**

Subunit-B (Extensions of Mendelian Genetics): Cellular reproduction (Mitosis and Meiosis); Chromosomal basis of Mendelism; Concept of Linkage and Crossing over; Genetic recombination; Brief idea about chromosome mapping in eukaryotes; Karyotype; Allelic and non-allelic interactions; Multiple alleles; Brief account of Quantitative inheritance.

_____ **09 Hours**

Subunit-C: (Chromosomal alterations / Mutations): Variations in chromosome structure (Deficiencies, Deletions, Duplications, Translocations, Inversions and Position effects); Giant Polytene chromosomes in Diptera; Variations in chromosome number (Aneuploidy and Polyploidy); Sex chromosomes. _____ **09 Hours**

UNIT-II

Subunit-D (Genetic Material): DNA as the genetic material, DNA structure and replication; DNA Protein interaction and Nucleosome model; Satellite and repetitive DNA.

_____ **05 Hours**

Subunit-E (Gene Expression): Modern concept of gene; RNA structure (m-RNA, t-RNA); Ribosome structure; Flow of genetic information; Genetic code; Mechanism of protein synthesis; Gene mutations; Regulation of gene expression in prokaryotes and eukaryotes.

_____09 Hours

Subunit-F (Extra Nuclear Inheritance): Presence and function of Mitochondrial and Plastid DNA; Plasmids. _____03 Hours

PRACTICAL

Code: BSCBOT 0407(P)

Cytogenetics

Credit = 1

1. Determination of probability by tossing coins.
2. Demonstration of phenomenon of Segregation.
3. Demonstration of phenomenon of Independent assortment.
4. Study of Cytoplasmic inheritance in *Mirabilis jalapa*.
5. Study of various genetic aspects with the help of models or images.

Suggested Readings

Cytogenetics:

- a. Brooker, R.J. 2012. Concepts of Genetics. McGraw-Hill.
- b. Brooker, R.J. 2012. Genetics; Analysis and Principles. McGraw-Hill.
- c. Daniel, H.L. 2014. Essential Genetics; A Genomics Perspective. Jones and Bartlett Learning.
- d. Gardner, E.J., Simmons, M.J. and Snustad, D.P. 1991. John Wiley & Sons, Inc.
- e. Gupta, P.K. 2011. Genetics. Rastogi Publications.
- f. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E. and Silver, L. M. 2011. Genetics: From Genes to Genomes. McGraw-Hill.
- g. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. 2012. Concepts of Genetics. Pearson Benjamin Cummings.
- h. Krebs, J.E., Goldstein, E.S. and Kilpatric, S.T. 2014. Lewin's Genes XI. Jones and Bartlett Learning.
- i. Pierce, B.A. 2012. Genetics. A Conceptual Approach. W.H. Freeman and Company. New York.
- j. Snustad, D.P. and Simmons, M. J. 2012. Principles of Genetics. John Wiley and Sons, Inc.

Code: BSCBOT0408

Evolutionary Biology

Credits = 3

Course duration- 40Hours

UNIT-I

Subunit-A (Origin of Life on Earth): Primitive earth; Major events in the history of life; Modern (Chemosynthetic) theory of life origin; Miller's experiment; Geological Time Table (Up to Epoch level with characteristic life form). Phylogenetic tree of life as defined by comparative rRNA gene sequencing. _____ **05 Hours**

Subunit-B (Palaeontology): Definition of fossils, Sub fossils, Pseudo fossils, Living fossils and Index fossils; Rocks and their types (Igneous, Sedimentary and Metamorphic rocks); fossilization process; Kinds of fossils and mode of their preservation; Techniques of study and reconstruction of fossils; Age determination of fossils by Radiocarbon dating technique.

_____ **15 Hours**

UNIT-II

Subunit-C (Organic Evolution): Meaning and evidences (Anatomical, Embryological, Physiological and Paleontological). _____ **03 Hours**

Subunit-D (Evolutionary and Population Genetics): Lamarck's theory of inheritance of acquired characters; Darwin's theory of natural selection; Hardy-Weinberg principle and its applications; Macro, Micro and Molecular evolution; Molecular clocks; Agents of evolutionary change (Mutation, Gene flow, Non-random mating, Genetic drift and Selection); Co-evolution; Cataclysmic evolution; Enzyme polymorphism; Species concept (Biological, Evolutionary and Ecological); Isolating mechanisms and type of speciation; Modern interpretation of Darwinism. _____ **17 Hours**

PRACTICAL

Code: BSCBOT 0408(P)

Evolutionary Biology

Credit = 1

1. Study of Homologous , Analogous and vestigial organs in plants.
2. Study of atavism with reference to plants.
3. Study of Evolutionary Biology with the help of models and images.

Suggested Readings

- **Evolutionary Biology:**
 - a. Brooker, R.J. 2012. Concepts of Genetics; (**Chapter-27: Evolutionary Genetics**). McGraw-Hill.

- b. Gardner, E.J., Simmons, M.J. and Snustad, D.P. 1991. Principles of Genetics; (**Chapter-22: Evolutionary Genetics**). John Wiley & Sons, Inc.
- c. Kay, L.E. 1993. The Molecular Vision of Life. 1993. Oxford University Press.
- d. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. 2012. Concepts of Genetics; (**Chapter-25: Population and Evolutionary Genetics**). Pearson Benjamin Cummings.
- e. Raven, P.H., Johnson, G.B., Mason, K.A., Losos, J.B. and Singer, S.R. 2014. Biology; (**Part-IV: Evolution**). McGraw-Hill.
- f. Snustad, D.P. and Simmons, M. J. 2012. Principles of Genetics; (**Chapter-24: Evolutionary Genetics**). John Wiley and Sons, Inc.
- g. Savage, J.M. 1969. Evolution. Oxford & IBH Publishing House.
- h. Verma, P.S. and Agarwal, V.K. 2012. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S.Chand & Co. Ltd.
- i. Volpe, E.P. 1992. Understanding Evolution. Universal Book Stall.

Code: BSCBOT0409

Cell Biology

Credits = 3

Course duration- 40Hours

UNIT-I

Subunit-A (Overview of Cells): Cell theory; Prokaryotic and Eukaryotic cells. **02 Hours**

Subunit-B (Chemistry of the Cell): Chemical and physical properties of water; Importance of water; Basics of macromolecules (Carbohydrates, Proteins, Lipids and Nucleic acids).

04 Hours

Subunit-C (Brief account of Basic Techniques used in Cell Biology): Principles of fixation and type of fixatives; Embedding; Staining methods; Resolving power and magnification of microscope; Differences between light and electron microscope and their types (Bright field, Dark field, Phase-contrast, Fluorescence, TEM and SEM); X-ray diffraction; Autoradiography; Cell fractionation; Methods of studying microorganisms. **08 Hours**

UNIT- II

Subunit-D (Viruses and Bacteria): General account and classification of viruses; Structural detail of TMV, HIV and λ -Bacteriophage; General account of Mycoplasma; Detailed ultrastructure, nutrition, reproduction and economic importance of bacteria. **08 Hours**

Subunit-E (Eukaryotic Cell Structure): Ultrastructure, chemical composition and functions of cell wall and plasma membrane; Ultrastructure, chemical composition and functions of

Nucleus, Mitochondria, Chloroplast, Golgi bodies, Endoplasmic reticulum, Ribosomes, Lysosomes, Peroxisomes, cytoskeleton and Vacuole. _____ **10 Hours**

Subunit-F (Chromosomes and Cell Division): Packaging of DNA in chromatin and chromosomes (Nucleosome model); Type of chromosomes on the basis of centromere position; Cell cycle and its regulation; Mitosis and Meiosis; Significance of cell division; Apoptosis; General account of Cancer and its molecular basis. _____ **08 Hours**

PRACTICAL

Code: BSCBOT 0409(P)

Cell Biology

Credit = 1

1. Study of some laboratory techniques (Maceration, Smearing, Squash and Micrometry).
2. Preparation of Fixing agents (Carnoy's fluid, Formalin-Aceto-Alcohol), Stains (Acetocarmine, Aniline blue, Crystal violet, Fast green, Safranin, Gram's iodine) and Mounting media (Glycerine jelly, Lactophenol).
3. Study of Mitosis by preparing Acetocarmine squash of onion root tip.
4. Study of Meiosis by smear preparation using Acetocarime stain.
5. Study of instrumentation used in Cell Biology (Equipment or Equipment image).

Suggested Readings

- **Cell Biology:**
 - a. Alberts, B., Johanson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. 2008. Molecular Biology of The Cell. Garland Science (Taylor & Francis Group).
 - b. Hardin, J., Bertoni, G. and Kleinsmith, L.J. 2012. Becker's World of The Cell. Pearson Benjamin Cummings.
 - c. Karp, G. 2010. Cell and Molecular Biology (concepts and experiments). John Wiley and Sons, Inc.
 - d. Lodish, H., Arnold, B., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P. 2013. Molecular Cell Biology. W. H. Freeman and Co. New York.
 - e. Powar, C.B. 1981. Cell Biology. Himalaya Publishing House.
-

Semester-V

Code: BSCBOT0510**Biochemistry****Credits = 3**

Course duration- 40Hours

UNIT- I

Subunit A(Thermodynamic Principles):First law of thermodynamics; Second law of thermodynamics; Concept of free energy and chemical equilibrium. _____ **03 Hours**

Subunit B(Chemical Foundations): Chemical and physical properties of water; pH scale; Acids, Bases and Buffers; Weak interactions (Hydrogen bonds, Ionic interactions, Hydrophobic interactions and VanderWaal interactions); Fundamentals of Macromolecules: Carbohydrates, Proteins, Lipids and Nucleic acids. _____ **12 Hours**

Subunit C(Basics of Enzymology): Discovery and characteristics of enzymes; International classification of enzymes; Important terms in Enzymology (Enzyme unit, Specific activity and Turnover number); Proenzymes; Concept of holoenzyme, apoenzyme, coenzyme and co-factors; Mode and mechanism of enzyme action; Enzyme kinetics (Michaelis-Menten equation); Enzyme inhibition (Competitive, Noncompetitive and Uncompetitive); Brief account of regulatory enzymes and Isoenzymes. _____ **09 Hours**

UNIT- II

Subunit D(Carbohydrate Metabolism): Aerobic and anaerobic respiration; ATP as Biological energy currency; Glycolysis, Gluconeogenesis, Krebs cycle and Electron transport mechanism; Redox potential; Mechanism of oxidative phosphorylation (Chemo-osmotic theory); Pentose phosphate pathway. _____ **08 Hours**

Subunit E(Lipid Metabolism): Saturated and unsaturated fatty acids; Fatty acid biosynthesis; Alpha and Beta oxidation. _____ **03 Hours**

Subunit F(Protein Metabolism): Transamination; Deamination; Biology of nitrogen fixation; Importance of Nitrate reductase; Ammonium ion assimilation. _____ **05 Hours**

PRACTICAL

Code: BSCBOT 0510(P)

Biochemistry

Credit = 1

1. Study of lab safety.
2. Qualitative analysis of Amino acids, Proteins, Carbohydrates, Lipids and Nucleic acids.
3. Demonstration of enzyme activity (Alpha-amylase, Invertase, Protease and Catalase) from plant or animal sources.
4. Separation of Amino acids by Paper Chromatography.
5. Study of equipments used in Biochemistry (Equipment or Equipment image).

Suggested Readings

- **Biochemistry:**
 - a. Berg, J.M., Tymoczko, J.L. and Stryer, L. 2012. Biochemistry. W. H. Freeman and Co. New York.
 - b. Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.H. 1987. Outlines of Biochemistry. John Wiley and Sons, Inc.
 - c. Jain, J.L., Jain, S. and Jain, W. 2004. Fundamentals of Biochemistry. S.Chand & Co. Ltd.
 - d. Nelson, D.L. and Cox, M.M. 2012. Lehninger Principles of Biochemistry. W. H. Freeman and Co. New York.
 - e. Voet, D. and Voet, J.G. 2011. Biochemistry. John Wiley and Sons, Inc.

Code: BSCBOT0511

Biotechnology

Credits = 3

Course duration- 40Hours

UNIT- I

Subunit A (Introduction to Biotechnology): Some selected definitions; Historical development of biotechnology; Traditional biotechnology; Modern biotechnology; Biotechnology as an interdisciplinary pursuit; Scope and importance of biotechnology; Biotechnology in India and global trends. _____ **05 Hours**

Subunit B (Genetic Engineering Methods): Aim of genetic engineering in biotechnology; Vectors and Restriction enzymes; Technique of making Recombinant DNA; Polymerase chain reaction; DNA fingerprinting. _____ **09 Hours**

UNIT- II

Subunit C (Plant Biotechnology): Historical background; Organization of plant tissue culture laboratory; Common type of culture media (MS, B5 and White's media) and their composition; Maintenance of aseptic conditions; Cell culture; Cellular totipotency; Somatic embryogenesis; Haploid production; Somatic hybridization and Cybridisation; Gene transfer techniques using *Agrobacterium tumefaciens*, electroporation and micro projectile gun; Transgenic plants for crop improvement; Cryopreservation. _____ **11 Hours**

Subunit D (Industrial and Microbial Biotechnology): Required laboratory facilities; Techniques of microbial culture; Procedures of microbial culture; Types of microbial culture; Measurement of microbial growth; Fermentation; Vessels for microbial culture

(Baffle flasks, shakers, fermenters); Microbial products (Primary and Secondary metabolites); Downstream processing; Single cell protein (SCP); Biofertilizers; Biopesticides; Outline of Hybridoma technology and production of monoclonal antibodies. _____ **08 Hours**

Subunit E (Biotechnology and Environment): General account of energy sources; Biomass as source of energy; Composition of biomass; Terrestrial and aquatic biomass; Wastes as renewable source of energy; composition of waste and their sources; Biomass conversion by Non-biological and biological processes; Energy plantations; Silviculture energy farms; Petroleum plants; Hydrocarbons from higher plants; Biogas; Bioremediation. _____ **07 Hours**

PRACTICAL

Code: BSCBOT 0511(P)

Biotechnology

Credit = 1

1. ***Demonstration of Equipments:** Spectrophotometer; Centrifuge; Electrophoresis unit; pH meter; Water bath; Incubator; Hot air oven; Shaker; Magnetic stirrer; Test tube shaker; Heating plate; Distillation plant; Autoclave; Laminar air flow; PCR; Analytical digital balance; Single-pan balance; Good quality microscope with projection system.
2. Sterilization techniques (Physical and Chemical methods).
3. *Media preparation for growing Bacteria.
4. *Preparation of Petri plates and Slants for culture.
5. Gram staining of Bacteria.
6. Isolation of milk proteins.
7. Cell viability assay by FDA and Evan's Blue method.
8. Preparation of MS medium for tissue culture

***Subject to the availability of lab facilities. Teacher may demonstrate with the help of images.**

Suggested Readings

- **Biotechnology:**
 - a. Dubey, R.C. 2007. A Textbook of Biotechnology. S.Chand & Co. Ltd.
 - b. Gupta, P.K. 2010. Elements of Biotechnology. Rastogi Publications.
 - c. Ignacimuthu, S. 1995. Basic Biotechnology. Tata McGraw-Hill Education.
 - d. Razdan, M. K. 1993. An Introduction to Plant Tissue Culture. Oxford & IBH Publishing Co. Pvt. Ltd.
 - e. Smith, J. E. 2002. Biotechnology. Cambridge University Press.

Code: BSCBOT0512

Molecular Biology

Credits = 3

Course duration- 40Hours

UNIT-I

Subunit-A (Major classes of Biological Molecules): Proteins; Nucleic acids; Polysaccharides and Lipids; some common methods used to study macromolecules (Ultracentrifugation, Electrophoresis, Chromatography and Electron microscopy).

_____ **05 Hours**

Subunit-B (Brief account of common experimental organisms used in Molecular Biology): Viruses; Bacteria; *Mus musculus* (Mice); *Drosophila melanogaster* (Fruit fly); *Caenorhabditis elegans* (Roundworm); *Danio rerio* (Zebra fish); *Saccharomyces cerevisiae* (Yeast); *Neurospora* and *Arabidopsis thaliana*. _____ **01 Hours**

Subunit-C (Basic Molecular Genetic Mechanisms): DNA as the genetic material; DNA structure; Forms of DNA (A, B, C, D, E, P and Z); DNA replication; DNA Protein interaction and Nucleosome model; Satellite and repetitive DNA; Modern concept of gene; RNA structure (m-RNA and t-RNA); Ribosome structure; Flow of genetic information; Genetic code; Mechanism of protein synthesis; Regulation of gene expression in prokaryotes and eukaryotes. _____ **08 Hour**

UNIT-II

Subunit-D (Recombinant DNA Technology): Gene cloning using vectors (Plasmids, cosmids, viruses, transposons, YAC, BAC and PAC); Binary and shuttle vectors; Restriction enzymes used in cloning; Complementary DNA; Polymerase chain reaction and gene amplification; DNA library; Colony hybridization; Blotting techniques (Southern blotting, Northern blotting and Western blotting); DNA sequencing (Maxam and Gilbert method; Sanger's method) and site directed mutagenesis; DNA fingerprinting; DNA footprinting.

_____ *15 Hours*

Subunit-E (Genomics and Proteomics): Definition; Type of genomics (Structural, functional and comparative); Introduction to genome sequencing and its significance; Human genome project; Outline of gene sequencing methods (Direct sequencing of Bacterial artificial chromosome, Random shotgun sequencing, Whole genome shotgun sequencing, Expressed sequence tag approach); Definition and objectives of proteomics; Relationship between gene and protein; Types of proteomics. _____ *08 Hours*

Subunit-F (Bioinformatics): Definition; Historical background; Database; Classification of database; Brief outline of sequences and nomenclature; Information sources (NCBI, GBD and MGD). Use of Bioinformatics tools in analysis. _____ *03 Hours*

PRACTICAL

Code: BSCBOT 0512(P)

Molecular Biology

Credit = 1

1. ***Demonstration of Equipments:** Spectrophotometer; Centrifuge; Electrophoresis unit; pH meter; Water bath; Incubator; Hot air oven; Shaker; Magnetic stirrer; Test tube shaker; Heating plate; Distillation plant; Autoclave; Laminar air flow; PCR; Analytical digital balance; Single-pan balance; Good quality microscope with projection system.
2. ***Isolation of Genomic DNA.**
3. ***DNA detection by Gel electrophoresis.**

***Subject to the availability of lab facilities. Teacher may demonstrate with the help of images.**

Suggested Readings

- **Molecular Biology:**

- a. Brown, T.A. 2006. Genomes 3. Garland Science.
- b. Freifelder, D. 1987. Molecular Biology. Jones and Bartlett Publishers.
- c. Tropp, B.E. 2012. Molecular Biology: Genes to Proteins. Jones and Bartlett Learning.
- d. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2007. Molecular Biology of The Gene. Pearson Benjamin Cummings.
- e. Weaver, R.F. 2012. Molecular Biology. McGraw-Hill.

Semester-VI

Code: BSCBOT0613

Ecology

Credits = 3

Course duration- 40Hours

UNIT-I

Subunit-A (Introduction to Ecology): History of ecology; Definition, scope and importance; Ecology as synthetic discipline. _____ **01 Hours**

Subunit-B (Environmental Factors): Climatic; Topographic; Biotic (species interactions); Fire and Edaphic (soil profile, physicochemical properties); Soil erosion and conservation.

_____ **05 Hours**

Subunit-C(Biogeochemical Cycles): Carbon; Nitrogen; Phosphorous; Sulphur and Hydrological cycle. _____ **02 Hours**

Subunit-D(Adaptations of Plants to Water and Salinity): Morphological and anatomical features of Hydrophytes, Xerophytes and Halophytes. _____ **03 Hours**

Subunit-E(Law of Liebig, Shelford and Limiting factors): Liebig's law of minimum; Shelford's law of tolerance; combined concept of limiting factors; Importance of limiting factors. _____ **02 Hours**

Subunit-F(Population Ecology): Introduction; Population characteristics, Genecology (Ecads, ecotypes and ecospecies). _____ **3 Hours**

Subunit-G(Community Ecology): Introduction; Qualitative, Quantitative and Synthetic characteristics; Methods of analysis. _____ **3 Hours**

UNIT-II

Subunit-H(Ecological Succession): Concept of climax; Type of succession, features and causes; detailed account of Hydrosere and Xerosere. _____ **03 Hours**

Subunit-I(Ecosystem Ecology): Structure (components) and functions (trophic levels, food chains, food webs, ecological pyramids and energy flow). _____ **03 Hours**

Subunit-J(Phytogeography): Definitions; Outline of Phyto-geographical regions of world and India; Botanical regions of India; Vegetation types of India. _____ **03 Hours**

Subunit-K(Environmental Pollution): Environmental pollutants; Kinds of pollution (Air, water, solid waste, noise and radioactive); Biomagnification; Cost of pollution; General account of Toxicology and Ecotoxicology. _____ **02 Hours**

Subunit-L(Biodiversity and Wildlife Conservation): Biodiversity hotspots; Value of biodiversity; Importance of wildlife; Brief account of ecological sub-divisions of India with reference to wildlife; Causes of species extinction; IUCN and Red Data Books; Concept of threatened species; Strategies and aim for conservation of wildlife in India; Special projects for endangered species in India (Project tiger, Gir lion project and Crocodile breeding project); Protected areas in India; National parks, Sanctuaries and Biosphere reserves. _____ **08 Hours**

Subunit-M(Climate Change): Greenhouse effect and its impact; Carbon trading; El Nino and La Nina effects; Ozone layer depletion and its impact. _____ **02 Hours**

PRACTICAL

Code: BSCBOT 0613(P)

Ecology

Credit = 1

1. Study the physical characteristics (Temperature, colour and texture) of the soil sample.
2. Determination of water holding capacity of the soil.
3. Determination of field capacity of the soil.
4. Study the chemical characteristics of the soil (Test the soil for Moisture content, Chloride, Nitrate, Carbonate, Phosphate, Sulphate, Potassium and Phosphorous).
5. Determine the base deficiency and pH of the soil sample.
6. Recording of temperature, relative humidity, light intensity, wind speed and rainfall of the atmosphere.
7. Determination of the minimum size of the quadrant by Species-Area-Curve method.
8. Determination of density, abundance and frequency of species by quadrant method.
9. Measurement of water quality, based on hardness and total alkalinity.
10. Measurement of water quality, based on dissolved oxygen and free carbon dioxide levels in water samples.

11. Morphological and anatomical features of hydrophytes, xerophytes, halophytes and parasites in relation to their habitats.

Suggested Readings

- **Ecology:**
 - a. Bhatia, A.L. 2010. Text Book of Environmental Biology. I.K.International Publishing House Pvt. Ltd.
 - b. Bhatia, K.N. 2002. A Treatise on Plant Ecology. Pradeep Publications.
 - c. Dash, M.C. 2001. Fundamentals of Ecology. Tata McGraw-Hill Education.
 - d. Jr. Miller, G.T. and Spoolman, S.E. 2011. Essentials of Ecology. Brooks / Cole. CENGAGE Learning.
 - e. Jr. Molles, M.C. Ecology; Concepts and Applications. 2008. McGraw-Hill.
 - f. Kormondy, E.J. 1996. Concepts of Ecology. Prentice Hall of India Pvt. Ltd. New Delhi.
 - g. Odum, E.P.1971. Fundamentals of Ecology. Saunders, Philadelphia.
 - h. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Brooks / Cole.
 - i. Sharma, P.D. 2012. Ecology and Environment. Rastogi Publications.

Code: BSCBOT0614

Plant Physiology

Credits = 3

Course duration- 40Hours

UNIT-I

Subunit-A(Plant Water Relations): Overview of plant cell structure and its chemical constituents;Importance of water to plant life; Water as Biological solvent, physical and chemical properties of water; Solutions and Colloids; Diffusion and osmosis; Water potential and DPD; Absorption and transport of water; Transpiration and physiology of stomata.

_____06 Hours

Subunit-B (Mineral Nutrition): Criteria of essentiality of minerals; Macro and micro elements and their role; Mechanism of mineral uptake; Deficiency and toxicity symptoms.

_____03 Hours

Subunit-C (Photosynthesis): Significance; Historical aspects; Photosynthetic pigments; Photosynthetically active radiations; Absorption and action spectra; Red drop and enhancement effect; Concept of two photosystems; Z- Scheme of photosynthetic electron transport chain; Theories of photophosphorylation; Types of photophosphorylation; C-3, C-4 pathway of Carbondioxide fixation; CAM plants; Photorespiration; Law of limiting factors.

___10 Hours

UNIT-II

Subunit-D (Transport of Organic Solutes): Mechanism of phloem transport; Source sink relationship; Factors affecting translocation. *___03 Hours*

Subunit-E(Plant Growth): Definitions; Phases of growth and development; Kinetics of growth; Measurement of growth. *___02 Hours*

Subunit-F (Plant Growth Hormones): History, discovery, physiological role and mechanism of action of Plant growth hormones: Auxins, Gibberellins, Cytokinins, Abscisicacid and Ethylene; Physiology of senescence. *___07 Hours*

Subunit-G (Photomorphogenesis): Definition; Discovery of Phytochromes, physiological role and mechanism of action; Cryptochromes and their role in development; Concept of Photoperiodism; Physiology of flowering and Florigen concept; Biological clocks; General account of Signal transduction. *___04 Hours*

Subunit-H(Seed Germination andDormancy):Definitions; Physiology of seed germination; Type of seed dormancy; Factors affecting seed dormancy; Methods of breaking seed dormancy; Significance of seed dormancy; Concept of vernalization. *___02 Hours*

Subunit-I(Plant Movements):Overview of plant movements;detailed account of Phototropism, Gravitropism and Nastic movements. *___03 Hours*

PRACTICAL

Code: BSCBOT 0614(P)

Plant Physiology

Credit = 1

1. Methods of expressing the strength of a solution (Percent solution, Molar solution, Molal solution and ppm solution).
2. Demonstration of Tyndall phenomenon.
3. Preparation of suspension, emulsion, suspenoid and emulsoid.
4. Demonstration of diffusion and Brownian movement.
5. Observation of streaming movement of the protoplasm.
6. Demonstration of Imbibition and Imbibition pressure.
7. Demonstration of Osmosis, Exosmosis and Endosmosis.
8. Measurement of Osmotic pressure of a plant cell.

9. Demonstration of effect of temperature and organic solvents on membrane permeability.
10. Demonstration of water movement through xylem.
11. Demonstration of root pressure and guttation.
12. **Stomatal studies:** Calculation of stomatal index; Effect of light and dark; Effect of Potassium ions and ABA.
13. Demonstration of transpiration, its water lifting power and loss of weight during transpiration.
14. Study of relative rates of transpiration from the upper and lower surfaces of the leaf; A comparative study (Four leaf method; Cobalt chloride method and bell-jar method).
15. Measurement of transpiration rate by Simple, Ganong, Farmer and Bose photometers.
16. Preparation of nutrient solution for water culture experiments (Study of mineral deficiency).
17. Test of Phosphate, Nitrate, Potassium, Calcium and Iron in plant tissues.
18. Isolation of photosynthetic pigments by differential solubility method and Paper chromatography technique (Ascending & Horizontal).
19. Determination of Absorption spectrum of Chlorophyll-a and Chlorophyll-b.
20. **Light reaction of Photosynthesis:** Effect of different wavelengths; Ganong's light screen; Chlorophyll essentiality; Oxygen evolution and its measurement (Wilmott bubbler & Ganong's photosynthometer); Hill reaction demonstration.
21. **Dark reaction of Photosynthesis:** Carbon dioxide essentiality; Starch synthesis in chloroplasts.
22. Test the presence of Carbohydrates, Amino acids, Proteins, Lipids and Nucleic acids in plant tissues.
23. Demonstration of Catalase activity, Effect of temperature, pH, and Substrate concentration.
24. **Translocation of Carbohydrates:** Translocation out of leaves; Phloem as translocation channel.
25. **Respiration:** Demonstration of anaerobic and aerobic respiration; Fermentation (Kuhne's fermentation vessel); Release of carbon dioxide and use of oxygen during aerobic respiration;
26. **Respiratory quotient (RQ):** Measurements by Ganong's respirometer and Double respirosopes.
27. **Growth:** Axial stem growth measurement by Arc-auxanometer and Pfeffer's (Automatic) auxanometer; Rooting effect of Auxins (IBA); Effect of Gibberellins (GA) on plant growth; Delaying of senescence by Cytokinins and fastening by Abscisic acid (ABA); Demonstration of etiolation in germinating seeds; Determination of seed viability by NTC test; Plant movements study (Phototropism, Geotropism, Hydrotropism and Seismonasty).

Suggested Readings

- **Plant Physiology:**
 - a. Bhatia, K.N. and Prashar, A.N. 1985. Plant Physiology. Trueman Book Company.
 - b. Buschanan, B., Gruissem, W., Jones, R. (Eds). 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.
 - c. Devlin, R.M. and Witham, F.H. 1983. Plant Physiology. Willard Grant Press.
 - d. Hopkins, W.G. and Hunner, N.P.A. 2009. Introduction to Plant Physiology. John Wiley and Sons, Inc.
 - e. Pandey, S.N. and Sinha, B.K. 2009. Plant Physiology. VikasPublishing HousePvt. Ltd. New Delhi.
 - f. Salisbury, F. and Ross, C. 1991. Plant Physiology. Wadsworth Pub. Co.
 - g. Taiz, L. and Zeiger, E. 2012. Plant Physiology. Sinauer Associates.

CORE ELECTIVE

Theory = 3 Credits Practicals = 1 Credit

In Core Electives, the teacher will conduct practicals based on theory course

Code: BSCBOT 0615

Plant Pathology

Credits = 4

Course duration- 40Hours

- **Introduction:** Definitions and terms used in plant pathology; Classification of plant diseases on the basis disease spread and major causal agent; Indian contribution to plant pathology. _____ **02 hours**
- **Disease Inciting Agents:** Fungi; Bacteria; Mycoplasma; Algae; Phanerogamic parasites; Nematodes; Viral; Deficiency and toxicity of minerals; Pathogenesis. _____ **02 hours**
- **Symptoms of Pant Diseases:** Symptoms caused by Fungi, Bacteria, Plant viruses, Mycoplasma and Nematodes. _____ **05 hours**
- **Dissemination of Plant Pathogens and Virus Transmission:** Dissemination by air, water, animals and man; Transmission of plant viruses. _____ **02 hours**

- **Plant Disease Forecasting:** Methods used in forecasting. _____ *01 hours*
- **Host parasite Inter-relationship and Interaction:** Mechanism of infection; Enzymes, growth regulators and toxins in plant disease. _____ *04 hours*
- **Effect of Climatic Conditions on Plant Diseases:** General account; Predisposing factors. _____ *01 hour*
- **Defence Mechanism:** General account; Structural and biochemical defence; Biochemical defence induced by the attacking pathogen; Inactivation of pathogen enzyme; Detoxification of pathogen toxins. _____ *05hours*
- **Principles of Plant Disease Control:** Cultural methods; Chemical methods; Breeding for disease resistance. _____ *05 hours*
- **Specific diseases:** White rust of crucifers; Late blight of potato; Apple scab; Loose smut of wheat; Rust of wheat; Early blight of potato; Tikka disease of groundnut; Red rot of sugarcane and Citrus canker. _____ *13 hours*

Code: BSCBOT 0616

Microbiology

Credits = 4

Course duration- 40Hours

- **Introduction to Microbiology:** Origin of microorganisms; Organisms of microbial world; Differences between prokaryotic and eukaryotic cells; Contribution of Antony van Leeuwenhoek, Louis Pasteur and Robert Koch; Scope of microbiology; Microbial evolution; Classification of microorganisms. _____ *04hours*
- **Microbiological Methods:** Sterilization methods; Media preparation; Isolation methods; Maintenance and preservation of cultures; Light and Electron microscopy; Gram's staining of bacteria. _____ *04hours*
- **Structure and Function of Bacterial Cells:** Size, shape and ultrastructure of bacterial cell; Bacterial nutrition; Bacterial photosynthesis; Endospore structure; Locomotion in bacteria. _____ *05hours*
- **General account of Viruses, Viroids and Prions.** _____ *03hours*
- **Basic Molecular Genetic Mechanisms and Microbial Genetics :** DNA as the genetic material; DNA structure; RNA structure (m-RNA and t-RNA); Ribosome structure; Flow of genetic information; Genetic code; Mechanism of protein synthesis; Gene mutations at molecular level; Regulation of gene expression in prokaryotes; Bacterial genetic recombination (Transformation, Conjugation and Transduction).
_____ *09hours*
- **Recombinant DNA Technology:** Gene cloning using vectors (Plasmids, cosmids, viruses, transposons); Binary and shuttle vectors; Restriction enzymes used in cloning; Complementary DNA; Polymerase chain reaction and gene amplification;

DNA library; Colony hybridization; Blotting techniques (Southern blotting, Northern blotting and Western blotting). _____ *09hours*

- **Economic Importance of Microbes:** Role of microbes in Industry, Health, Agriculture and Environment. _____ *03hours*
- **Microbial Ecology:** Microbial interactions; Extremophiles; General account of Soil, Air and Water microbiology. _____ *03hours*

Suggested Readings

- **Microbiology:**
 - a. Dubey, R.C. and Maheshwari, D.K. 2005. A Textbook of Microbiology. S.Chand & Co.
 - b. Madigan, M.T., Martinko, J.M., Stahl, D.A. and Clark, D.P. 2012. Brock Biology of microorganisms. Benjamin Cummings.
 - c. Powar, C.B. and Dagainawala, H.F. 2003. General Microbiology (Vol. I & II). Himalaya Publishing House.
 - d. Tortora, G.J., Funke, B.R. and Case, C.L. 2013. Microbiology-An Introduction. Benjamin Cummings.
 - e. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. 2013. Prescott, Harley and Klein's Microbiology. McGraw-Hill.

Code: BSCBOT 0617

Techniques in Biological Research

Credits = 4

Course duration- 40Hours

- **Basic Principles:** Lab safety and hygiene; Units of measurements; Basic statistical concepts for biochemical analysis. _____ *03 hours*
- **pH and Buffers:** pH Scale; pH Meter; Buffers and their types. _____ *03hours*
- **Cell Culture Techniques:** Introduction; Organisation of cell culture laboratory; Equipments; maintenance of aseptic environment; Media preparation for bacteria and stem cell culture. _____ *04 hours*
- **Microscopy Techniques:** Light microscopy, Electron microscopy and their types; Sample preparation for light and electron microscopy; Imaging of living cells and tissues. _____ *06hours*
- **Centrifugation Techniques:** Basic principles; Preparative and Analytical centrifugation. _____ *02hours*
- **Spectroscopy Techniques:** Basic principles; Ultraviolet and Visible spectroscopy; Brief account of Infrared and Raman spectroscopy; EPR, NMR and XRD. _____ *07 hours*
- **Chromatographic Techniques:** Principles of Chromatography; Gas chromatography; High-Performance liquid chromatography. _____ *05hours*

- **Electrophoretic Techniques:** General principles; Capillary electrophoresis; Electrophoresis of proteins and nucleic acids. _____ *04hours*
- **Immunochemical Techniques:** Fluorescent activated cell sorting (FACS).__ *03hours*
- **Mass spectrometric Techniques:** Introduction; Ionisation; Mass analysers and detectors. _____ *03 hours*

Suggested Readings

- **Biological Techniques:**
 - a. Sadasivam, S. and Manickam, A. 2009. Biochemical Methods. New Age International Pvt. Ltd. Publishers.
 - b. Plummer, D.T. 1971. An Introduction to Practical Biochemistry. McGraw-Hill.
 - c. Wilson, K. and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

Code: BSCBOT 0618

Utilization of Plants

Credits = 4

Course duration- 40Hours

- **Introduction:** Origin of Cultivated plants; Importance of plant and plant products to mankind. _____ *01hours*
- **Fibres and Fibre Plants:** Classification of fibres; Cotton; Flax; Hemp; Jute; Ramie; Sisal; Coconut and Kapok. _____ *03 hours*
- **Cereal Crops:** Wheat; Rice; Maize; Barley; Oats and Rye. _____ *03 hours*
- **Sugars, Starches and Cellulose Products:** Sources of sugars; Sugarcane and sugar beet; Starches and starch products; Cellulose products; Paper and paper making. _____ *03 hours*
- **Legumes:** Legumes; Forage crops; Tree legumes. _____ *02hours*
- **Fatty oils and Waxes:** Sources of fatty oils; Waxes and Soap substitutes. __ *03 hours*
- **Fruits:** Classification of fruits; Common fruits of Indian subcontinent; Fruits of temperate and tropical regions; Important fruit plants of Himachal Pradesh; Preservation of fruits. _____ *03 hours*
- **Vegetables:** Common vegetables of Indian subcontinent; Earth vegetables; Herbage vegetables and Fruit vegetables. _____ *03hours*

- **Spices, Condiments and other Flavouring materials:** Common Spices, Condiments and flavouring materials of Indian subcontinent; Spices obtained from bark, flower and flower buds, fruits, seeds and leaves; Other spices and flavouring materials. . _____ *03hours*
- **Fumitories and Masticatories:** Tobacco; Betel and Cola. _____ *02 hours*
- **Beverages:** Tea; Coffee and Cocoa. _____ *03hours*
- **Forest Products:** Importance, structure and mechanical properties of wood; Factors influencing the mechanical properties of wood; Uses of wood; Indian forests; Important timber plants of India and their identification; Timber wealth of Himachal Pradesh. _____ *03 hours*
- **Rubber and Other Latex Products:** Para rubber; Substitutes for Para rubber; Synthetic rubber. _____ *03hours*
- **Tanning and Dye Material:** Tannins and tanning industry; Sources of tanning material; Kaththa: A small scale industry in India; Dyes and pigments. . _____ *02 hours*
- **Medicinal Plants:** History of medicinal plants; Drug plants; Classification of drugs; psychoactive drugs. _____ *03 hours*

Suggested Readings

- **Utilization of Plants:**
 - a. Kocchar, S.L. 1998. Economic Botany in the Tropics. McMillan India Ltd., New Delhi.
 - b. Sharma, O.P. 1996. Hills Economic Botany (Late Dr. A.F. Hill adapted by Sharma, O.P.1996), Tata McGraw-Hill Co. Ltd., New Delhi.
 - c. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic Botany-Plants in our World. McGraw-Hill. New York.

Code: BSCBOT 0619

Ethnobotany

Credits = 4

Course duration- 40Hours

- Scope and aim of ethnobotany in developing world; Father of Indian ethnobotany. . _____ *01hours*
- Ethnoecology/Traditional resource management.. _____ *02hours*
- Agriculture: origins, traditional, industrialized, sustainable. _____ *03hours*
- Crop domestication, evolution, and conservation of genetic diversity. _____ *04hours*

- Interactions of humans and plants in the past: archaeobotany, paleoethnobotany, ethnohistory. _____ **04hours**.
- Indigenous knowledge, linguistic ethnobotany, and ethnobiological classification.. _____ **04hours**
- Quantitative ethnobotany and survey field methods. _____ **04hours**
- Plants in symbolism, ritual, and religion.. _____ **01hours**
- Plants in material culture / fibers, plant structure related to uses. _____ **02hours**
- Plants in nutrition and dietary patterns / Fermented foods. _____ **02hours**
- Systems of traditional medicine in India; Medicinal floral wealth of Himachal Pradesh. _____ **04hours**
- Phytochemistry / Human uses of plant secondary metabolites / Foods as medicines; Psychoactive plants. _____ **03 hours**
- Global movement of plants and human cultures. _____ **02hours**
- Non-timber forest products / plants and markets. _____ **02hours**
- Plants and Indigenous cultures of India with special reference to Himachal Pradesh.. _____ **02hours**

Suggested Readings

- **Ethnobotany:**

- a. Cotton, C.M. 1996. Ethnobotany; Principles and Applications. John Wiley and Sons, Inc.
- b. Schultes, R.E. and Reis, S.V. 2008. Ethnobotany; Evolution of a Discipline. Timber Press.
- c. Medicinal Plants Traditional Knowledge. Editor: P.C.Trivedi.2006 I.K.International Publishing House Pvt.Ltd.

Code: BSCBOT 0620

Plant breeding

Credits = 4

Course duration- 40Hours

- **Nature and Scope of Plant Breeding:** History of plant breeding; Definitions; Aims and objectives. _____ **04hours**
- **Mode of Reproduction in Relation to Plant Breeding:** Importance; Methods of reproduction; Mode of reproduction. _____ **04hours**
- **Methods of Crop Improvement:** Selection; Hybridization; Introduction and acclimatization. _____ **04hours**
- **Mass Selection:** Definition; Procedure; Applications and uses; Advantages and limitations. _____ **04hours**
- **Pure line and Pure line Selection:** Definitions; Characters; Field technique; Uses; Advantages and disadvantages. _____ **04hours**
- **Clone and Clonal Selection:** Definitions; Characters; Importance; Field technique; Uses; Advantages and disadvantages. _____ **02hours**
- **Hybridization:** Definition and types; Applications and objectives; Prerequisites; Advantages and disadvantages. _____ **05hours**

- **Heterosis and Hybrid Vigour.** _____ *05hours*
- **Plant Introduction and Acclimatization.** _____ *03hours*
- **Mutation Breeding and Breeding for Disease Resistance.** _____ *05hours*

Suggested Readings

- **Plant Breeding:**

- a. Allard, R.W. 1999. Principles of Plant Breeding. John Wiley and Sons, Inc.
- b. Chaudhari, H.K.1971. Elementary Principles of Plant Breeding.

Code: BSCBOT 0621

Biodiversity

Credits = 4

Course duration- 40Hours

- **Biodiversity Science:** Introduction; Biodiversity concept and definition; Biodiversity hot spots; Scope of biodiversity. _____ *03hours*
- **Genetic Diversity:**Nature and origin of genetic variations; Determination of genetic diversity. _____ *02hours*
- **Species Diversity:** Species inventory; Species diversity. _____ *03hours*
- **Agrobiodiversity and Cultivated Taxa:** Origin and evolution of cultivated species diversity; Diversity in domesticated species; Wild plants; Feral plants; Domesticated microbes. _____ *05hours*
- **Ecosystem Diversity:** Classification of ecosystems; Measurement of ecosystem diversity; Major ecosystem types of the world. _____ *05hours*
- **Values and Uses of Biodiversity:** Biodiversity values; Ethical and aesthetic values; Precautionary principle; Methods of biodiversity valuation; Uses of plants.____ *05hours*
- **Loss of Biodiversity:** Loss of genetic diversity; Loss of species diversity; Loss of ecosystem diversity; Loss of agrobiodiversity. _____ *05hours*
- **Biodiversity Conservation:** Need of biodiversity conservation; Conservation of genetic, species, and ecosystem diversity; *In-situ* and *ex-situ* consevations; Management of plant biodiversity; Role of women. _____ *09 hours*
- **Role of Biotechnology:** Biotechnology in utilisation of biodiversity; Adverse impacts of biotechnology on biodiversity. _____ *03 hours*

Suggested Readings

- **Biodiversity:**

Krishnamurthy, K.V. 2003. Textbook of Biodiversity. Science publishers, Inc.

Code: BSCBOT 0622

Bioinformatics

Credits = 4

Course duration- 40Hours

- **Introduction to Bioinformatics:** Definition;Importance and scope. _____*02hours*
- **Major classes of Biological Molecules:** Proteins; Nucleic acids; Polysaccharides and Lipids. _____*02 hours*
- **Basic Molecular Genetic Mechanisms:** DNA as the genetic material; DNA replication; Modern concept of gene; RNA structure (m-RNA and t-RNA); Ribosome structure; Flow of genetic information; Genetic code; Mechanism of protein synthesis. _____*04hours*
- **Genetic Engineering Methods:** Introduction to genetic engineering; Vectors and Restriction enzymes; Technique of making Recombinant DNA. _____*04hours*
- **Database:** Introduction to database; Sequence databases; Structure databases; Genome mapping databases; Biological culture and stock collection databases; Enzyme and metabolic pathways databases; Information retrieval from biological databases; Information sources. _____*04hours*
- **Sequence Alignment and Database Searching:**Introduction to sequence alignment; Pairwise alignment; Significance of sequence alignment and types; Evolutionary basis of sequences alignment. _____*04hours*
- **Phylogenetic Methods:** Phylogenetic models; Phylogenetic data analysis; Tree building methods; Phylogenetic software. _____*04hours*
- **Predictive methods:** Predictive methods using nucleotide and protein sequences. . _____*04hours*
- **Genomics and Proteomics:** Definition; Type of genomics (Structural, functional and comparative); Introduction to genome sequencing and its significance; Human genome project; Outline of gene sequencing methods (Direct sequencing of Bacterial artificial chromosome, Random shotgun sequencing, Whole genome shotgun sequencing, Expressed sequence tag approach); Definition and objectives of proteomics; Relationship between gene and protein; Types of proteomics. __ *10hours*
- **Bioinformatics Software and its Applications.** _____*02hours*

Suggested Readings

- **Bioinformatics:**
 - a. Attwood, R.E. and Smith-Pary, D.J. and Phukan,S. 1999. Introduction to Bioinformatics. Pearson Education Ltd.
 - b. Harisha, S. 2007. Fundamentals of Bioinformatics. I.K. International Publishing House Ltd.

OPEN ELECTIVE COURSES

Theory = 3 Credits Practicals = 1 Credit

In Open Electives, the teacher will conduct practicals based on theory course

Code: BSCBOT 0623

Floriculture

Credits = 4

Course duration- 40Hours

- **Introduction:** History of gardening; Importance and scope of floriculture and landscape gardening. _____ **02hours**
- **Nursery Management and Routine Garden Operations:** Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators. _____ **08hours**
- **Ornamental Plants:** Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai. _____ **09hours**
- **Principles of Garden Designs:** English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. _____ **05 hours**
- **Landscaping Places of Public Importance:** Landscaping highways and Educational institutions. _____ **05hours**
- **Commercial Floriculture:** Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, *Chrysanthemum*, *Dahlia*, *Gerbera*, *Gladiolous*, Marigold, Rose, *Lilium*, Orchids). _____ **07hours**
- **Diseases and Pests of Ornamental Plants.** _____ **04 hours**

Suggested Readings

- **Floriculture:**

Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

Code: BSCBOT 0624

**Mushroom Cultivation
Credits = 4**

Course duration- 40Hours

Introduction: History and introduction; Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. _____ **05hours**

Classification: Systematic position, morphology, distribution, structure and life cycle of *Agaricus*; Types of mushroom. _____ **03hours**

Cultivation: Equipments for mushroom spawn, Laboratory, culture room, spawn production mushroom farm layout and mushroom shed;

Paddy straw mushroom – substrate, spawn making; Methods – bed method, polythene bag method, field cultivation.

Oyster mushroom cultivation –substrate, spawning, pre-treatment of substrate.Maintenance of mushroom.

Cultivation of white button mushroom – spawn, composting, spawning, harvesting.

_____**20hours**

Disease Management:Diseases- Common pests, disease prevention and control measures.

_____**05hours**

Processing: Blanching, steeping, sun drying, canning, pickling, freeze drying._____**05 hours**.

Storage: short term and long term storage. _____ **02 hours**

Suggested Readings

- **Mushroom Cultivation:**

- a. Bahl, N. 1988. Handbook of Mushroom. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi

- b. Krishnamoorthy, A.S., Marimuthu, T. and Nakkern, S. 2005 **Mushroom Biotechnology** . TNAU Press, Coimbatore, India
- c. Harander, S. 1991. Mushrooms. The Art of Cultivation Sterling Publishers.
- d. Tripathi, D.P. 2005. Mushroom Cultivation. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.

GENERAL INTEREST COURSES

Code: BSCBOT 25

Psychoactive Plants and Society

Credits = 1

Course duration- 40Hours

- **Introduction:** Historical aspects; Definition of psychoactive plants; Distribution of psychoactive principle in plant groups. _____ **04hours**
- **Some Examples of Psychoactive Plants :** *Atropa belladonna, Cannabis sativa, Datura metel, Erythroxylon coca, Lophophora williamsii, Mandragora officinarum, Nicotiana tabacum, Ipomea violacea, Papaver somniferum, Amanita muscaria, Psilocybe mexicana;* Psychoactive plants with reference to Himachal Pradesh.

_____ **14hours**
- **Type of Psychoactive Drugs:** Stimulants, Hallucinogens and Depressants; Medicinal use; Designer drugs. _____ **06 hours**
- **Chemical Nature of Psychoactive Drugs:** Alkaloids and THC. _____ **06hours**
- **Drug Abuse:** Development of drug abuse and drug addiction; Methods of taking drugs (Powders and Snuffs, Smoking, External application); Deterioration of health; De-addiction; Illegal trade names of Opium; Drug trafficking. _____ **06hours**
- **Legislation:** Highlights of NDPS Act-1985. _____ **04hours**

Suggested Readings

- **Psychoactive Plants and Society:**

- a. Kocchar, S.L. 1998. Economic Botany in the Tropics. McMillan India Ltd., New Delhi.
- b. Sharma, O.P. 1996. Hills Economic Botany (Late Dr. A.F. Hill adapted by Sharma, O.P.1996), Tata McGraw-Hill Co. Ltd., New Delhi.
- c. Shultes, R.E. 1976. Hallucinogenic Plants. A Golden Guide. Western Publishing Company.
- d. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic Botany-Plants in our World. McGraw-Hill. New York.

Code: BSCBOT 26

Credits = 1

Digital Photography

Course duration- 40Hours

- **Introduction:** Digital camera features; Advantages of digital photography; Point and shoot camera; DSLR camera; Digital video camera; Image sensor; Image processor. _____ *05hours*
- **Basic Camera Operation:** Camera settings (Quality settings, white balance, ISO); Aperture and shutter speed; Built in flash and external flash. _____ *05hours*
- **Some Useful Accessories:** Camera bags, flash units, Tripods, monopods and other stabilizers; Battery and memory cards. _____ *03hours*
- **Lenses:** Basics of lens; Understanding the lens optics; Standard, zoom, wide-angle, telephoto and speciality lenses; Lens filters. _____ *03hours*
- **Digital Photography Techniques:** Metering mode selection; choosing the proper exposure; Creative techniques. _____ *05 hours*
- **Image Editing:** File formats (TIF, JPEG and RAW); Advantages and disadvantages of RAW format; Basic colour correction; Adjusting exposure and sharpening of images;Cropping. _____ *06hours*
- **Tackling Photographing Subjects:** Photographing people, sports, nature and landscapes. _____ *06hours*
- **Digital Photography for Research and Documentation.** _____ *04hours*
- **Techniques for Unusual Images:** Moving water and firework display. _____ *03hours*.

Suggested Readings

- **Digital Photography:**
 - a. Simon, D. 2004. Digital Photography Bible. Wiley Publishing.
 - b. Canfield, J. 2007. The Digital SLR Guide. Peachpit Press.