B.Sc. (Programme) Life Science

THREE-YEAR FULL-TIME PROGRMME

Choice based credit system

(Six Semester Course)

[BOTANY COMPONENT]

COURSE CONTENTS

APPROVED IN THE COMMITTEE OF COURSES HELD ON JUNE 9, 2015

Structure of B.Sc. Life Science under CBCS
[BOTANY COMPONEN]

Core Courses –Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniatae)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

Discipline Specific Electives-Botany (Any two)

Semester V DSE-I	**DSE-I(Any one)** 1.Cell and Molecular Biology 2. Bioinformatics
Semester VI DSE-II	**DSE-II(Any one)** 3. Economic Botany and Biotechnology 4. Analytical Techniques in Plant Sciences
Ability Enhancement Compulsory Courses	
	1. Environmental Science 2. English/MIL Communication
Skill Enhancement Courses (four)	
Semester III SEC-I	1. Biofertilizers
Semester IV SEC-II	2. Medicinal Botany
Semester V SEC-III	3. Ethnobotany
Semester VI SEC-IV	4. Intellectual Property Rights

Structure of B.Sc. Programme (Life Science)/B.Sc. Medical under CBCS

[BOTANY COMPONEN]

Semester	Core Course	Ability Enhancement Compulsory Courses	Skill Enhancement Courses (SEC)(4)	Discipline Specific Elective DSE(4)
I	CC-Botany I 1. Biodiversity(Microbes, Algae, Fungi and Archegoniatae) CC-Zoology I CC-Chemistry I	English/MIL Communication/ Environmental Science		
II	CC- Botany II 2. Plant Ecology and Taxonomy CC-Zoology II CC-Chemistry II	English/MIL Communication/ Environmental Science		
III	CC- Botany III 3. Plant Anatomy and Embryology CC-Zoology III CC-Chemistry III		SEC-I 1. Biofertilizers	
IV	CC- Botany IV 4. Plant Physiology and Metabolism CC-Zoology IV CC-Chemistry IV		SEC-II 2. Medicinal Botany	
V			SEC-III 3.Ethnobotany	DSE-I Botany (Any one) 1. Cell and Molecular Biology 2. Bioinformatics
VI			SEC-IV	DSE-II Botany (Any one)

			4.Intellectual Property Right	3. Economic Botany and Biotechnology 4. Analytical Techniques in Plant Sciences

Details of Courses

Core Courses –Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniatae)
2. Plant Ecology and Taxonomy
3. Plant Anatomy and Embryology
4. Plant Physiology and Metabolism

Discipline Specific Electives-Botany (Any two)

1. Economic Botany and Biotechnology
2. Cell and Molecular Biology
3. Analytical Techniques in Plant Sciences
4. Bioinformatics

Ability Enhancement Compulsory Courses

1. Environmental Science
2. English/MIL Communication

Skill Enhancement Courses (four)

Botany

1. Biofertilizers
2. Medicinal Botany
3. Ethnobotany
4. Intellectual Property Right

Scheme of B.Sc. Programme (Life Sciences)/ B.Sc. Medical under CBCS
[BOTANY COMPONENT]

SEMESTER	COURSE OPTED	COURSE NAME	CREDITE
I	I Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science	4
	Core Course Botany- I	Biodiversity (Microbes, Algae, Fungi and Archegoniatae)	4
	Core Course Botany **I Practical**	Biodiversity(Microbes, Algae, Fungi and Archegoniatae -Practical	2
	Core course Zoology I	Biodiversity-Animals	4
	Core Course Zoology I	Biodiversity-Animals –Practical Lab.	2
	Core course Chemistry I	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	4
	Core course Chemistry I Practical	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons - Lab	2
II	II Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science	4
	Core Course Botany II	Plant Ecology and Taxonomy	4
	Core Course Botany -II **Practical**	Plant Ecology and Taxonomy-Practical	2
	Core course Zoology II	Comparative Anatomy and Developmental Biology	4
	Core Course Zoology II Practical	Comparative Anatomy and Developmental Biology-Lab	2
	Core course Chemistry II	Chemical Energetics, Equilibria &Functional Group Organic Chemistry	4
	Core Course Chemistry II Practical	Chemical Energetics, Equilibria &Functional Group Organic Chemistry-Lab	2
III	Core course Botany- III	Plant Anatomy and Embryology	4
	Core Course Botany -III **Practical**	Anatomy and Embryology of Angiosperms- Practical	2
	Core Course Zoology III	Physiology and Biochemistry	4
	Core Course Zoology III	Physiology and Biochemistry-	2

	Practical	Lab	
	Core course Chemistry III	Conductance, Electrochemistry & Functional Group Organic Chemistry-II	4
	Core Course Chemistry III Practical	Conductance, Electrochemistry & Functional Group Organic Chemistry-Lab	2
	Skill Enhancement Botany Course-I	SEC-I Botany 1. Biofertilizers	2
IV	Core Course Botany IV	Plant Physiology and Metabolism	4
	Core Course Botany –IV **Practical**	Plant Physiology and Metabolism- Practical	2
	Core course Zoology IV	Genetics and Evolutionary Biology	4
	Core Course Zoology IV Practical	Genetics and Evolutionary Biology -Lab	2
	Core course Chemistry IV	Chemistry of s-and p-block elements, States of matter and Chemical Kinetics	4
	Core Course Chemistry IV Practical	Chemistry of s-and p-block elements, States of matter and Chemical Kinetics-Lab	2
	Skill Enhancement CourseBotany-II	SEC Botany-II 2. Medicinal Botany	2
V	Discipline Specific Elective Botany –I	DSE Botany I (Any one) 1. Cell and Molecular Biology 2. Bioinformatics	4
	Discipline Specific Elective Botany I Practical	DSE-Botany I -Practical	2
	Discipline Specific Elective Zoology I	DSE- I Zoology	4
	Discipline Specific Elective Zoology I Practical		2
	Discipline Specific Elective Chemistry I	DSE- I Chemistry I	4
	Discipline Specific Elective Chemistry I Practical		2

	Skill Enhancement Course Botany-III	SEC Botany-III 3.Ethnobotany	2
VI	Discipline Specific Elective Botany –II	DSE Botany II (Any one) 3. Economic Botany and Biotechnology 4. Analytical Techniques in Plant Science	4
	Discipline Specific Elective Botany II **Practical**	DSE Botany II Practical	2
	Discipline Specific Elective Zoology II	DSE Zoology II	4
	Discipline Specific Elective Zoology II Practical		2
	Discipline Specific Elective Chemistry III	DSE Chemistry -II	4
	Discipline Specific Elective Chemistry III Practical		2
	Skill Enhancement Course Botany –IV	SEC Botany -IV 4.Intellectual Property Rights	2
Total			120

Semester I
Core Course: Botany I
Biodiversity (Microbes, Algae, Fungi and Archegoniatae)
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: Microbes **(10 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; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

U nit 2: Algae **(12 Lectures)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia*. Economic importance of algae

U nit 3: Fungi **(12 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, life cycle of *Rhizopus* (Zygomycota) *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4: Introduction to Archegoniate (**2 Lectures)**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

U nit 5: Bryophytes **(10 Lectures)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 6: Pteridophytes **(8 Lectures)**

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

Unit 4: Gymnosperms **(6 Lectures)**

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

Practical

5. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
6. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
7. Gram staining
8. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron

micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
9. *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
10. *Alternaria:* Specimens/photographs and tease mounts.
11. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
12. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
13. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
14. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
15. ***Marchantia***- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
16. ***Funaria***- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
17. ***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).
18. ***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).
19. ***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).
20. ***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).
21. ***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. & r.l.s. stem (permanent slide).

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd 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. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Semester II

Core Course Botany –II
Plant Ecology and Taxonomy
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Introduction **(2 Lectures)**

Unit 2: Ecological factors **(10 Lectures)**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford

law of tolerance. Adaptation of hydrophytes and xerophytes.

U nit 3: Plant communities **(6 Lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 4: Ecosystem **(8 Lectures)**

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: Phytogeography **(4 Lectures)**

Principle biogeographical zones; Endemism

U nit 6 Introduction to plant taxonomy **(2 Lectures)**

Identification, Classification, Nomenclature.

Unit 7 Identification **(4 Lectures)**

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

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. **(6 Lectures)**

Unit 9 Taxonomic hierarchy **(2 Lectures)**

Ranks, categories and taxonomic groups

Unit 10 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.

U nit 11 Classification **(6 Lectures)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit 12 Biometrics, numerical taxonomy and cladistics **(4 Lectures)**

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

Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b)Study of biotic interactions of the following: Stem parasite (*Cuscuta)*, Root parasite

(Orobanche), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
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):Brassicaceae -*Brassica, Alyssum / Iberis;* Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanum nigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae -*Asphodelus / Lilium / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Semester III

Core Course Botany –III
Plant Anatomy and Embryology
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Meristematic and permanent tissues **(8 Lectures)**
Root and shoot apical meristems; Simple and complex tissues.

U nit 2: Organs **(4 Lectures)**
Structure of dicot and monocot root stem and leaf.

Unit 3: Secondary Growth **(8 Lectures)**
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

U nit 4: Adaptive and protective systems **(8 Lectures)**
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5: Structural organization of flower **(8 Lectures)**
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 6: Pollination and fertilization **(8 Lectures)**
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: Embryo and endosperm **(8 Lectures)**
Endosperm types, structure and functions; Dicot and monocot embryo; Embryoendosperm relationship.

Unit 8: Apomixis and polyembryony (**8 Lectures)**
Definition, types and practical applications.

Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Semester IV
Core Course Botany –IV
Plant Physiology and Metabolism
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: Plant-water relations (8 Lectures)
Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

U nit 2: Mineral nutrition (8 Lectures)
Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem (6 Lectures)
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Photosynthesis (12 Lectures)
Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration.

Unit 5: Respiration (6 Lectures)
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: En zymes (4 Lectures)
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism (4 Lectures)
Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (6 Lectures)
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

U n it 9: Plant response to light and temperature (6 Lectures)
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Practical
1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Discipline Specific Elective Courses

Discipline Specific Elective Botany
Cell and Molecular Biology
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: Techniques in Biology **(8 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; X-ray diffraction analysis.

Unit 2: Cell as a unit of Life **(2 Lectures)**
The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3: Cell Organelles **(20 Lectures)**
Mitochondria:- Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.
Chloroplast-Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.
ER, Golgi body & Lysosomes:-Structures and roles.
Peroxisomes and Glyoxisomes:_Structures, composition, functions in animals and plants and biogenesis.
Nucleus:- Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Cell Wall **(6 Lectures)**
The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5: Cell Cycle **(6 Lectures)**
Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6: Genetic material **(6 Lectures)**
DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.
DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ø (theta) mode of replication, replication of linear, ds-DNA, replicating the 5′end of linear chromosome including replication enzymes.

Unit 7: Transcription (Prokaryotes and Eukaryotes) **(6 Lectures)**
Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Unit 8: Regulation of gene expression **(6 Lectures)**
Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Practical

1.To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2.Study of the photomicrographs of cell organelles

3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
7. Study of mitosis and meiosis (temporary mounts and permanent slides).
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
13. Study DNA packaging by micrographs.
14. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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.

Discipline Specific Elective Botany
Bioinformatics
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: Introduction to Bioinformatics (5 Lectures)
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2: Databases in Bioinformatics (5 Lectures)
Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3 : Biological Sequence Databases (25 Lectures)
National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.
Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.
Swiss-Prot: Introduction and Salient Features.

Unit 4: Sequence Alignments (10 Lectures)
Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: Molecular Phylogeny (8 Lectures)
Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 6: Applications of Bioinformatics (7 Lectures)
Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Practical

11. Nucleic acid and protein databases.
12. Sequence retrieval from databases.
13. Sequence alignment.
14. Sequence homology and Gene annotation.
15. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. _II Edition. Benjamin Cummings.

Discipline Specific Elective Botany
Economic Botany and Biotechnology
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: Origin of Cultivated Plants **(4 Lectures)**
Concept of centres of origin, their importance with reference to Vavilov's work
Unit 2: Cereals **(4 Lectures)**
Wheat -Origin, morphology, uses
U nit 3: Legumes **(6 Lectures)**
General account with special reference to Gram and soybean
U nit 4: Spices **(6 Lectures)**
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)
U nit 5: Beverages **(4 Lectures)**
Tea (morphology, processing, uses)
U nit 6: Oils and Fats **(4 Lectures)**
General description with special reference to groundnut
Unit 7: Fibre Yielding Plants **(4 Lectures)**
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)
Unit 8: Introduction to biotechnology **(2 lecture)**
U nit 9: Plant tissue culture **(8 Lectures)**
Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications
Unit 10: Recombinant DNA Techniques **(18 Lectures)**
Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Practical

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Discipline Specific Elective Botany
Analytical Techniques in Plant Sciences
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: Imaging and related techniques **(15 Lectures)**
Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation **(8 Lectures)**
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.**(**

Unit 3: Radioisotopes
Use in biological research, auto-radiography, pulse chase experiment. **(4 Lectures)**

Unit 4: Spectrophotometry
Principle and its application in biological research. **(4 Lectures)**

Unit 5: Chromatography **(8 Lectures)**
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of proteins and nucleic acids **(6 Lectures)**
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 7:Biostatistics **(15 Lectures)**
Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Practicals

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separate DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.

2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Skill Enhancement Courses

Skill Enhancement Course
Biofertilizers

(Credits 2)
Lectures: 30

Unit 1: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
(4 Lectures)

Unit 2: *Azospirillum:* isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. **(8 Lectures)**

Unit 3: Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.
(4 Lectures)

Unit 4: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.
(8 Lectures)

Unit 5: Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. **(6 Lectures)**

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New _Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic _Farming Akta Prakashan, Nadiad

Skill Enhancement Course
Medicinal Botany
(Credits 2)
Lectures: 30

Unit 1: History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, 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: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **(10 Lectures)**

Unit 2: Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. **(10 Lectures)**

Unit 3: Ethnobotany and Folk medicines. Definition; 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)**

Suggested Readings

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.

Skill Enhancement Course
Ethnobotany
(Credits 2)
Lectures: 30

Unit 1: Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. **(6 Lectures)**

Unit 2: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. **(6 Lectures)**

Unit 3: Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia,Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). **(10 Lectures)**

Unit 4: Ethnobotany and legal aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. **(8 Lectures)**

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3) Lone et al,. Palaeoethnobotany
4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, _Lucknow, India.
5) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – _Chichester
7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah._8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996_9)

INTELLECTUAL PROPERTY RIGHTS (IPR)

(Credits: 02)
Theory: 30 Lectures

In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.

Introduction to Intellectual Property:
Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights
Introduction, How to obtain, Differences from Patents.

Trade Marks
Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.
Differences from Designs.

Patents
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Geographical Indications
Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs
Definition, How to obtain, features, International design registration.

Layout design of integrated circuits
Circuit Boards, Integrated Chips, Importance for electronic industry.

Trade Secrets
Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

Different International agreements
(a) Word Trade Organization (WTO):
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty
(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity
IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India

Licensing and technology transfer.

Reference Books:

- N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
- Manjula Guru & *M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
- P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy*, Tata McGraw-Hill (2001).
- Arthur Raphael Miller, Micheal H.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell,* West Group Publishers (2000).
- Jayashree Watal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.