B.Sc. (Hons.)
BOTANY

Detailed Syllabus

Programme Code: BOTB
Duration: 3 Years

EFFECTIVE FROM SESSION: 2019-2020

Department of Life Sciences & Biotechnology
Faculty of Science
CHHATRAPATI SHIVAJI MAHARAJ UNIVERSITY PANVEL, NAVI MUMBAI

About the Programme

The **B. Sc. (Honors) Botany** Program is aimed at imparting knowledge on the fundamentals of Botany. This program is completed in six semesters. The course delivery methods include seminars, lectures, and laboratory work. Today plant science is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):

The programme educational objectives of the B. Sc. (Hons.) Botany programme are:

PEO1	Equip students with essential knowledge and technical skills to study plants and related subjects in a holistic manner.
PEO2	To train the learners in all areas of plant biology using appropriate combinations of core and elective papers with significant inter-disciplinary components.
PEO3	Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem.
PEO4	Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

PROGRAMME OUTCOMES (PO):

After completion of the B. Sc. (Hons.) Botany programme students will be able to:

PO1	Inculcate strong fundamentals on modern and classical aspects of Botany.
PO2	Build life skills in Edible mushroom cultivation, Biofertilizer production, Greenhouse maintenance and Seed technology through value-added courses.
PO3	Create platform for higher studies in Botany.
PO4	Facilitate students to take-up successful career in Botany
PO5	Demonstrate the ability to use skills in Botany and its various areas of technology.

SEMESTER I

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MCRB1010	Microbiology and Phycology	4	0	0	30	70	100	4
DSC	BINB1020	Biomolecules and Cell Biology	4	0	0	30	70	100	4
GE	**	Generic Elective - I	4	0/1	4/0	30	70	100	4
AECC	ENGG1000	English Communication	2	0	0	15	35	50	2
DSC	MCRB1011	Microbiology and Phycology Lab	0	0	4	15	35	50	2
DSC	BINB1021	Biomolecules and Cell Biology Lab	0	0	4	15	35	50	2
GE	**	Generic Elective – I Lab	0	1/0	0/4	15	35	50	2
		Total	**14**	**0**	**12**	**150**	**350**	**500**	**20**

Ability Enhancement Compulsory Courses (AECC)

Semester	Offering Department	Course Code	Course Name	(L-T-P)	Credits
I	English	ENGG1000	English Communication	2-0-0	2

MCRB1010	MICROBIOLOGY AND PHYCOLOGY	4L:0T:0P	4 Credits

Course objectives:

The objectives of this course are

1. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms (Bacteria and algae).

UNIT- 1: Microbial World (Origin and Evolution of Life, Microbial diversity (12Lectures)

1.1. Discovery of microorganisms, origin of life, spontaneous, biogenesis, Pasteur experiments, germ theory of disease.

1.2. Classification of microorganisms – R.H. Whittaker's five kingdom concept, Carl Woese's- Domain system.

1. 3. Brief account of special groups of bacteria- Archaebacteria, Mycoplasma, Chlamydia, Actinomycetes, Rickettsias and Cyanobacteria.

UNIT- 2 : VIRUSES (12 Lectures)

2.1. Viruses- Discovery, general account, structure& replication of –T4 Phage (Lytic, Lysogenic) and TMV, Viroids, Prions.

2.2. Plant diseasescaused by viruses– Symptoms, transmission and control measures (Brief account only).

2.3. Study of Tobacco Mosaic, Bhendi Vein clearing and Papaya leaf curl diseases.

UNIT 3: BACTERIA (12 Lectures)

3. 1. Bacteria: Discovery, General characteristics, cell structure andnutrition.

3.2. Reproduction- Asexual and bacterial recombination (Conjugation, Transformation, Transduction).

3.3. Economic importance of Bacteria.

UNIT –4: ALGAE (12Lectures)

4.1. General account - thallus organization and reproduction in Algae.

4.2. Fritsch classification of Algae (up to classes only) and economic importance.

4.3. Structure, reproduction and life history of Oedogonium, Ectocarpus and Polysiphonia.

UNIT 5: FUNGI (12 Lectures)

5.1. General characteristics and outline classification (Ainsworth).

5.2. Structure, reproduction and life history of Rhizopus (Zygomycota),Penicillium (Ascomycota), and Puccinia (Basidiomycota).

5.3. Lichens-Structure and reproduction; ecological and economic importance.

Text /Reference Books:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop understanding on the concept of microbial nutrition
2. Classify viruses based on their characteristics and structures
3. Develop critical understanding of plant diseases and their remediation.

4. Examine the general characteristics of bacteria and their cell reproduction/ recombination
5. Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance
6. Conduct experiments using skills appropriate to subdivisions

MCRB1011	**MICROBIOLOGY AND PHYCOLOGY LAB**	**0L:0T:4P**	**4 Credits**

LIST OF EXPERIMENTS:

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).
5. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), Volvox, *Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia,Procholoron* through electron micrographs, temporary preparations and permanent slides.

BINB1020	**BIOMOLECULES AND CELL BIOLOGY**	**4L:0T:0P**	**4 Credits**

Course objectives:

The objectives of this course are

1. To understand the structure of cell and various cellular events. .
2. To learn about cell theory and techniques for fractionation of sub cellular organelles.
3. To understand the composition of cytoskeleton and extracellular matrix.
4. To acquire knowledge of cell cycle, cell division and cell death mechanisms

UNIT 1: Biomolecules (12 lectures)

1.1. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

1.2. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

1.3. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

1.4. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides;

Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

UNIT 2: The cell **(12 lectures)**

2.1. Cell as a unit of structure and function;

2.2. Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

3. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

UNIT 3: Cell organelles **(12 lectures)**

3.1. Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

3.2. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

3.3. Chloroplast, mitochondria and peroxisomes: Structural organization;Function; Semiautonomous nature of mitochondria and chloroplast.

3.4. Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids;

3.5. Golgi Apparatus and lysosomes– organization, protein glycosylation, protein sorting and export from Golgi Apparatus.

UNIT 4: Cell cycle and cell death **(12 lectures)**

4.1.Phases of eukaryotic cell cycle- mitosis and meiosis;

4.2. Regulation of cell cycle- checkpoints, role of protein kinesis.

4.3. Apoptosis

UNIT 5: Tools of cell biology **(12 lectures)**

5.1. Light Microscope- phase contrast and dark field

5.2. Chromatography

5.3. Cell culture

5.4. Cell fractionation- centrifugation

Text /Reference Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company

5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. 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

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Fundamental understanding of Bio-molecules: Building blocks of living system
2. Understanding of structure and function of cell: Prokaryotic and Eukaryotic cells system.
3. Understanding the Basic of cellular transport system and cellular inheritance.
4. Understanding of the function of various subcellular organelles
5. They will be acquainted to various microscopic techniques to visualize subcellular organelles

BINB1021	**BIOMOLECULES AND CELL BIOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Study of microscope
2. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
3. Study of cell and its organelles with the help of electron micrographs.
4. Study the phenomenon of plasmolysis and deplasmolysis.
5. Study the effect of organic solvent and temperature on membrane permeability.
6. Study different stages of mitosis and meiosis.
7. Study of structure of prokaryotic and eukaryotic cell.

SEMESTER II

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BOTB2010	Diversity of Archaegoniates&Plant Anatomy	4	0	0	30	70	100	4
DSC	BOTB2020	Plant physiology and Ecology	4	0	0	30	70	100	4

GE	**	Generic Elective - II	4	0/1	4/0	30	70	100	4
AECC	EVSG2000	Environmental Science	2	0	0	15	35	50	2
DSC	BOTB2011	Diversity of Archaegoniates& Plant Anatomy lab	0	0	4	15	35	50	2
DSC	BOTB2021	Plant Physiology and Ecology Lab	0	0	4	15	35	50	2
GE	**	Generic Elective – II Lab	0	1/0	0/4	15	35	50	2
		Total	**14**	**0**	**12**	**150**	**350**	**500**	**20**

Ability Enhancement Compulsory Courses (AECC)

Semester	**Offering Department**	**Course Code**	**Course Name**	**(L-T-P)**	**Credits**
II	Basic Sciences	EVSG2000	Environmental Studies	2-0-0	2

BOTB2010	**DIVERSITY OF ARCHAEGONIATES &PLANT ANATOMY**	**4L:0T:0P**	**4 Credits**

Course Objectives:

2. This course aims at making a familiarity with special groups of plants joined together by a common feature of sexual reproduction involving Archegonia.
3. To Create an understanding by observation and table study of representative members of phylogenetically important groups should be able to make students learn the process of evolution in a broad sense.
4. To Study of morphology, anatomy, reproduction and developmental changestherein through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants

UNIT – 1: BRYOPHYTES (12Lectures)

1.1 Bryophytes: General characters, Classification (up to classes)

1.2. Structure, reproduction and Life history of Marchantia, and Funaria.

1.3. Evolution of Sporophyte in Bryophytes.

UNIT – 2: PTERIDOPHYTES (12Lectures)

2.1. Pteridophytes: General characters, classification (up to Classes)

2.2. Structure, reproduction and life history of Lycopodium, and Marsilea.
2.3. Heterospory and seed habit.
2.4. Evolution of stele in Pteridophytes.

UNIT – 3: GYMNOSPERMS (12Lectures)

3.1. Gymnosperms: General characters, classification (up to classes)
3.2. Morphology, anatomy, reproduction and life history of Pinus and Gnetum
3.3. Economic importance with reference to wood, essential oils and drugs

UNIT –4: Tissues and Tissue systems (12Lectures)

4.1.Meristems - Root and Shoot apical meristems and their histological organization.
4.2.Tissues – Meristematic and permanent tissues (simple, complex, secretory)
4.3.Tissue systems–Epidermal, ground and vascular.

UNIT – 5. Secondary growth (12Lectures)

5.1. Anomalous secondary growth in Achyranthes, Boerhaavia and Dracaena.
5.2. Study of local timbers of economic importance-Teak, Rosewood, Red sanders and Arjun (Tella maddi).

Course Learning Outcomes:

1. Demonstrate an understanding of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms
2. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
3. Understanding of plant evolution and their transition to land habitat.
4. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperm

Text /Reference Books

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.

Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

BOTB2011	**DIVERSITY OF ARCHAEGONIATES &PLANT ANATOMY LAB**	**0L:0T:2P**	**4 Credits**

LIST OF EXPERIMENTS

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).

2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria:* Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of *Stemonitis* sporangia.
9. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

BOTB2020	**PLANT PHYSIOLOGY AND ECOLOGY**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To explain plant water relations and elucidate mineral nutrients that plants require, how they are obtained, metabolized and transported;
2. To describe physiological details of photosynthesis and respiration in plants;
3. To describe enzymes, hormones, environmental responses and nitrogen metabolism required for plant growth and development.

Detailed Syllabus:

UNIT 1: Carbon and nitrogen metabolism in plants (12 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation pointNitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.Nitrogen cycle

UNIT 2: Plant Growth and development (12 Periods)

Growth and development: Definitions, phases of growth, growth curve Growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Concept of photoperiodism and vernalization

Unit 3: Introduction to Ecology 12 periods

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficienciesNutrient and biogeochemical cycle with one example of Nitrogen cycle Human modified ecosystem

Unit 4: Population 12 periods

Unitary and Modular populationsUnique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density-dependent and independent factorsPopulation interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit 5: Community and Applied Ecology 12 periods

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example Theories pertaining to climax community

Text /Reference Books:

1. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
2. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
3. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
4. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand basic life processes of plants
2. Understand important chemical reactions and pathways involved in major processes of plants Have knowledge about hormones and other chemical/ non chemical factors that affect the plant growth characteristics
3. Understand the role and function of organism at a larger level in its environment
4. Link connections between various organisms and their environment
5. Enlist various factors living and non-living that influence the normal functioning of the ecosystem.

BOTB2021	**PLANT PHYSIOLOGY AND ECOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant
8. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
9. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community
10. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2
11. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

SEMESTER III

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BOTB3010	Anatomy of Angiosperms	4	0	0	30	70	100	4
DSC	BOTB3020	Economic botany	4	0	0	30	70	100	4
DSC	BOTB3030	Reproductive biology	4	0	0	30	70	100	4
GE	**	Generic Elective - II	4	0/1	4/0	30	70	100	4
DSC	BOTB3011	Morphology and anatomy	0	0	4	15	35	50	2
DSC	BOTB3021	Economic botany	0	0	4	15	35	50	2
DSC	BOTB3031	Reproductive biology	0	0	4	15	35	50	2
GE	**	Generic Elective - II	0	1/0	0/4	15	35	50	2
SEC	**	Skill enhancement 1	0	0	2	15	35	50	2
		Total	**16**	**0**	**22**	**185**	**455**	**650**	**26**

BOTB3010	ANATOMY OF ANGIOSPERMS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To inculcate the basics of tissues and anatomical features of plants.
2. To impart the knowledge about the various aspects of morphogenesis.
3. To understand the key aspects of embryology of Angiosperms

Unit 1: Introduction and scope of Plant Anatomy (4 Lectures)

Applications in systematics, forensics and pharmacognosy**.**

Unit 2: Structure and Development of Plant Body (6 Lectures)

Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 2: Tissues (12 Lectures)

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit 3: Apical meristems (15 Lectures)

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.

Unit 4: Vascular Cambium and Wood (15 Lectures)

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Unit 5: Adaptive and Protective Systems (8 Lectures)

Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Text /Reference Books:

1) Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2) Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3) Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4) Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their
5) Structure, Function and Development. John Wiley and Sons, Inc

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop an understanding of concepts and fundamentals of plant anatomy examine the internal anatomy of plant systems and organs
2. Develop critical understanding on the evolution of concept of organization of shoot and root apex.
3. Analyze the composition of different parts of plants and their relationships
4. Evaluate the adaptive and protective systems of plants

BOTB3011	**ANATOMY OF ANGIOSPERMS LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1) Study of anatomical details through permanent slides/temporary stain mounts/ macerations/
2) museum specimens with the help of suitable examples.
3) Apical meristem of root, shoot and vascular cambium.
4) Distribution and types of parenchyma, collenchyma and sclerenchyma.
5) Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates;
6) xylem fibres.
7) Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
8) Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
9) Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
10) Root: monocot, dicot, secondary growth.
11) Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
12) Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
13) Adaptive Anatomy: xerophytes, hydrophytes.
14) Secretory tissues: cavities, lithocysts and laticifers.

BOTB3020	**ECONOMIC BOTANY**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To relate the principles of Economic Botany to other disciplines in biology.
2. To relate useful plants to the affairs of mankind.
3. To relate useful plants to the local and world economy.

Unit 1: Origin of Cultivated Plants (6 lectures)

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals and Legumes (6 lectures)

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets. Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man

and ecosystem.

Unit 3: Sources of sugars and starches (4 lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 4 : Spices and Beverages (6 lectures)

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper Tea, Coffee (morphology, processing & uses)

Unit 5 : Sources of oils and fats (10 lectures)

General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

COURSE OUTCOME

1. Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
2. Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
3. Develop a basic knowledge of taxonomic diversity and important families of useful plants
4. Increase the awareness and appreciation of plants & plant products encountered in everyday life
5. Appreciate the diversity of plants and the plant products in human use

Text/ Reference Books

1) Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2) Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,
3) The Netherlands.
4) Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

BOTB3021	**ECONOMIC BOTANY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1) **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2) **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3) **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests),
4) Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
5) **Spices:** Black pepper, Fennel and Clove (habit and sections).
6) **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

7) **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.

8) **Essential oil-yielding plants**: Habit sketch of *Rosa, Vetiveria, Santalum* and *Eucalyptus* (specimens/photographs).

BOTB3030	REPRODUCTIVE BIOLOGY	4L:0T:0P	4 Credits

1. Course learning objectives:

The objectives of this course are

1. To have knowledge of the flowering and fruiting
2. To study reproduction processes,
3. To study role of pollinators, anther, ovule and seed development

2. Detailed Syllabus:

Unit 1: Introduction Reproductive development (4 lectures)
History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.
Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

Unit 2: Anther and pollen biology (10 lectures)
Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 3: Ovule, Pollination and fertilization (10 lectures)
Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female
gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.
Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 4: Self incompatibility (10 lectures)
Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

Unit 5: Embryo, Endosperm and Seed (10 lectures)
Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms

Text /Reference Books:

1) Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.

2) Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3) Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4) Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Learn about double fertilization and their significance
2. Know about the Structure and development of dicot and monocot embryos.
3. Understand the basic knowledge about tissue culture tools, medium, sterilization and techniques of tissue culture.
4. Learn about the production of Synthetic seeds & significance
5. Study about the role of tissue culture in crop improvement

BOTB3031	**REPRODUCTIVE BIOLOGY LAB**	**0L:0T:4P**	**2 Credits**

SUGGESTIVE LIST OF EXPERIMENTS:

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph);
3. Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

SEMESTER IV

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits

DSC	BTEB4030	Molecular biology	4	0	0	30	70	100	4
DSC	BOTB4010	Phytogeography	4	0	0	30	70	100	4
DSC	BOTB4020	Plant systematics	4	0	0	30	70	100	4
GE	**	Generic Elective - II	4	0/1	4/0	30	70	100	4
DSC	BTEB4031	Molecular biology lab	0	0	4	15	35	50	2
DSC	BOTB4011	Phytogeography lab	0	0	4	15	35	50	2
DSC	BOTB4021	Plant systematics lab	0	0	4	15	35	50	2
GE	**	Generic Elective – II lab	0	1/0	0/4	15	35	50	2
SEC	**	Skill enhancement II	0	0	2	15	35	50	2
		Total	**16**	**0**	**22**	**185**	**455**	**650**	**26**

BTEB4030	**MOLECULAR BIOLOGY**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To acquaint students with DNA Replication, Repair and Genetic Engineering.
2. Impart the knowledge of molecular Biology Techniques.

Detailed Syllabus:

Unit 1 Hereditary material- DNA (12 lectures)

1.1 DNA as the vehicle of inheritance- Experimental evidence -Griffith, McLeod, McCarty and Avery, HerscheyChase experiments.

1.2.Definition of Gene, organization of genes and non-coding

1.3.DNA in prokaryotes and Eukaryotes - unique, moderately repetitive and highly repetitive DNA sequence, Satellite DNA.

1.4. Cot value.

Unit 2 DNA replication in prokaryotes (12 lectures)

2.1. DNA Replication in Prokaryotes - Semi-conservative DNA replication,

2.2. DNA Polymerases and its role, E.coli Chromosome Replication,

2.3.Bidirectional Replication of Circular DNA molecules.

2.4. Rolling Circle Replication, DNA

Unit 3 DNA replication (12 lectures)

3.1. Replication in Eukaryotes

3.2. DNA Recombination –Holliday Model for Recombination

3.3. Transformation

Unit 4 Mutations(12 lectures

4.1. Definition and Types of Mutations.

4.2. Mutagenesis and Mutagens.(Examples of Physical, Chemical and Biological Mutagens)

4.3. Types of Point Mutations,

1.1. DNA REPAIR Photoreversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.

Unit 5 Genetic and Chromosomal variation (12 lectures)

5.1. Genetic variation and chromosomal basis of inheritance Types: Discontinuous and continuous

5.2. Molecular basis of allelic variation.

5.3. Historical development of chromosomal theory, nature of chromosome, chromosomal behaviour 5.4. Inheritance in eukaryotes

Text /Reference Books:

1. Upadhya- Molecular Biology- Himalaya pub.
2. Watson – Molecular biology of gene- Pearson pub.
3. David Freifelder- Microbial Genetics – Narosa Pub.
4. David Freifelder– Molecular Biology – Narosa pub.
5. Gardner – Principals of Genetics – Wiley international pub.
6. Albert Bruce- Molecular biology of the cell- garland science.
7. Loddish - Molecular cell biology – W-H. freeman
8. Lewin – Genes X- Oxford
9. Fundamentals of Cell and Molecular biology-Baig, Telang and Ingle-Amruta

Genome- T.A. Brown- John Wiley

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand basic molecular biology terms and definitions
2. Understand the molecular model of DNA and its replication in various ways
3. Define mutations and predict their outcomes
4. Enlist various possibilities and probable reasons which may lead to mutations
5. Explain certain medical conditions related to one's genetics
6. Elucidate the concept of heredity and passing of information from generation to other

BTEB4031	**MOLECULAR BIOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Isolation and purification of DNA from plant sources (genomic)
2. Agarose Gel Electrophoresis of the genomic DNA
3. Quantitative analysis of DNA by DPA
4. Quantitative analysis of RNA by Orcinol method
5. Study of DNA repair mechanism by photo reactivation

Determination of Tm value of DNA

BOTB4010	**PHYTOGEOGRAPHY**	**4L:0T:2P**	**5 Credits**

COURSEOBJECTIVE

1. To give a fundamental understanding of the distribution of vascular plants and of the basic

models which describe it.

2. To know about the floristic regions and plant formations of the Planet, in the light of previous continental and climatic evolution.
3. To learn floristic recording of specific habitats and the assessment of their naturality on the basis of chorological and life form spectra of the flora.

Unit I: Introduction, soil and water 15 lectures

Basic concepts; Levels of organization. Abiotic and biotic Components and their interrelationships and dynamism, homeostasis. Soil: Origin; Types and Formation; Composition; Physical, Chemical and Biological components; Soil profile. Types of soils in India. Water: States of water in the environment; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Atmospheric moisture; Water in soil; Ground water table. Water
resources of India

Unit II: Ecological adaptations, Population ecology 15 lectures

Variations in adaptation of plants in relation to light, temperature, water, wind and fire. Biotic interactions: Competition: Inter- and intraspecific competition; Ammensalism, heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation, Population ecology: Characteristics and population growth, population regulation, life history strategies; *r* and *k* selection. Ecological Speciation.

Unit III: Plant Communities and Ecosystem 15 lectures

Community characteristics: analytical and synthetic; Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect; Succession: processes, types; climax concept. Primary vs Secondary succession. Ecosystem: Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Ecosystems of India.

Unit IV: Functional Aspects of Ecosystem and Phytogeography 15 lectures

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus. Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phyto-geographical division of India; Local Vegetation.

Course outcomes

On completion of this course, the students will be able to:

1. Understand core concepts of biotic and abiotic
2. Classify the soils on the basis of physical, chemical and biological components
3. Analysis the phytogeography or phytogeographical division of India
4. Evaluate energy sources of ecological system
5. Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
6. Conduct experiments using skills appropriate to subdivisions

Text/ Reference Books

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

BOTB4011	**PHYTOGEOGRAPHY LAB**	**4L:0T:2P**	**5 Credits**

LIST OF EXPERIMENTS:

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 of various soil and water samples (with pH meter, universal indicator/Lovibond comparator and/or pH paper strip)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid
5. titration method.
6. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
7. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
8. Study of morphological adaptations of hydrophytes and xerophytes (four each).
9. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).
10. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
11. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

BOTB4020	**PLANT SYSTEMATICS**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To gain the knowledge on the taxonomy, phylogeny of plants
2. To Understand systematic and its importance in bioresource utilization and biodiversity management.
3. To learn about Nomenclature pattern, Phylogeny, Classification systems of the plants.
4. To learn about Nomenclature pattern, Phylogeny, Classification systems of the plants.

Unit I: Significance of Plant systematics and Taxonomic hierarchy

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology embryology, cytology, phytochemistry and molecular data. Field inventory; Importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: intended (yolked) and bracketed keys. Phenetics vs. Cladistics, Taxonomic Hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy;

Species concepts (biological, morphological, evolutionary).Modes of speciation. Problems with species concepts.Rankless system of phylogenetic systematics

Unit II: Botanical Nomenclature and System of Classification 15 lectures

Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids. System of classification: Natural system of classification (Bentham and hooker), Takhtajan classification of Angiosperms, Principles of Angiosperm Phylogeny Group (APG IV) classification.

Unit III: Biometrics, Numerical Taxonomy and Cladistics 15 lectures
Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit IV: Phylogenetic Systematics 12 lectures
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology etc). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship
(phylogenetic tree, cladogram).

Text /Reference Books:

1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi.3rdedition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics- A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.
5. Sambamurty A.V.S.S. (2005). Taxonomy of Angiosperms. I. K. International Pvt. Ltd., New Delhi. Singh, V., Pande, P. C. & Jain, D. K. (2008). Taxonomy and conomic Botany. Rastogi Publications, Meerut.
6. Pandey, B. P. (2009). A Textbook of Botany Angiosperms. . S. Chand and CompanyLtd., New Delhi.
7. Hall, B.G. (2011). *Phylogenetic Trees Made Easy: A How-To Manual*. Sinaue Associates, Inc. USA
8. Any local/state/regional flora published by BSI or any other agency

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium
2. Evaluate the Important herbaria and botanical gardens
3. Interpret the rules of ICN in botanical nomenclature
4. Assess terms and concepts related to Phylogenetic Systematics
5. Generalize the characters of the families according to Bentham & Hooker's system of classification

BOTB4021	PLANT SYSTEMATICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Study of vegetative and floral characters of the following families (Description, V.S. lower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae - *Ranunculus, Delphinium*
Brassicaceae - *Alyssum / Iberis*
Papaveraceae - *Argemone*
Myrtaceae - *Eucalyptus, Callistemon*
Umbelliferae - *Coriandrum /Anethum / Foeniculum*
Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
Solanaceae - *Solanumnigrum/Physalis*
Lamiaceae - *Salvia/Ocimum*
Euphorbiaceae - *Euphorbia hirta/ Jatropha, Croton*
Liliaceae - *Asphodelus/Lilium/Allium*
Poaceae - *Triticum/Hordeum/Avena*

2. Field visit (local or outside depending on situation) –
3. Mounting of a properly dried and pressed specimen of any 20 wild plant with Herbarium label (to be submitted in the record book).
4. Construction of plant phylogenetic trees using various loci (rbcL, ITS, trnLetc) with various phylogenetic methods (Neibour Joining, Maximum Likelihood etc)

SEMESTER V

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BTEB5010	Principles of genetics	4	0	0	30	70	100	4
DSC	MCRB5010	General microbiology	4	0	0	30	70	100	4
DSE	**	Discipline specific elective 1	4	0	0	30	70	100	4
DSE	**	Discipline specific elective 2	4	0/1	4/0	30	70	100	4
DSC	BTEB5011	Principles of genetics	0	0	4	15	35	50	2
DSC	MCRB5011	General Micrology	0	0	4	15	35	50	2
DSE	**	Discipline specific elective 1lab	0	0	4	15	35	50	2
DSE	**	Discipline specific elective 2 lab	0	1/0	0/4	15	35	50	2
		Total	**16**	**0**	**20**	**180**	**420**	**600**	**24**

BTEB5010	GENETICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To acquaint students with concepts in Genetics
2. To impart skills in Techniques in Genetic Analysis and Population Genetics

Detailed Syllabus

Unit 1: Mendels Law (12 lectures)

1.1.Mendel's Laws of HeredityMonohybrid Cross: Principleof Dominance and Segregation. Dihybrid Cross: Principle ofIndependent Assortment.

1.2 Application of Mendel's Principles Punnett Square.

1.3. Mendel's Principle in HumanGenetics. Incomplete Dominance and Co-dominance. Multiple Alleles.Allelic series.Variations among the effect of the Mutation.Genotype and Phenotype.

1.1.Environmental effect on the expression of the Human Genes. Gene Interaction.Epistasis.

Unit 2: Genetic analysis (12 lectures)

2.1. Genetic analysis in Bacteria- Prototrophs, Auxotrophs.

2.2. Bacteriophages: Lytic and Lysogenic Development of Phage. Mechanism of Genetic Exchange in Bacteria:

2.3. Conjugation; Transformation; Transduction; (Generalized Transduction, Specialized Transduction)

2.4. Bacterial Transposable Elements

Unit 3: Prokaryotic and Eukaryotic transcription (12 lectures)

3.1. Transcription Process in Prokaryotes :RNA Synthesis; Promoters and Enhancers;

3.2. Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain.

3.3. Transcription in Eukaryotes Transcription of Protein Coding Genes by RNA Polymerase.

Unit 4: Genetic code (12 lectures)

4.1. Nature of Genetic Code.

4.2. Wobble Hypothesis.

4.3.Translation: Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination)

Unit 5: Regulation in prokaryotes and eukaryotes (12 lectures)

5.1. Gene regulation In prokaryotes: In Bacteria: *Lac* operon of *E.coli, trp* Operon of *E.coli.*

5.2. In Eukaryotes: Operons in Eukaryotes; Control of Transcriptional Initiation

5.3. Jumping genes in maize

Text /Reference Books:

1. General Principles of Microbiology- Stanier
2. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill
3. Genetics, (2006) Strickberger MW - (Prentice Hall, India)
4. Human Genetics- A. M. Winchester – MacMillan Press
5. iGenetics- Peter Russell -Pearson Education
6. Microbial Genetics- Freifelder –Narosa Publishing House

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Define and explain the three laws of Heredity
2. Explain the patterns of breeding and cross breeding
3. Explain the concept of alleles, their dominant and recessive nature
4. Explain unusual patterns of inheritance and deviations from the normal laws

BTEB5011	**GENETICS LAB**	**0L:0T:2P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Isolation, Quantitative Analysis and AGE of Genomic DNA from Bacteria and Yeast.
2. Mutations by UV rays
3. Mutations by chemical agents such as; base analogue, intercalating agents or Alkylating agents.
4. Bacterial transformation
5. Bacterial conjugation
6. Bacterial transduction
7. Karyotyping with the help of photographs

MCRB3020	**GENERAL MICROBIOLOGY**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To become aware with the contributions of Louis Pasteur, Edward Jenner and Robert Koch in microbiology and immunology.
2. To get acquainted with the discovery of antibiotics and their targets, drug/antibiotic resistance, preventive and therapeutic approaches of infectious diseases, hospital acquired infections.
3. To Understand the importance of microorganisms as model systems in genetics and biochemistry.
4. To know the contribution of gut microbiome in human health.
5. To understand the concepts of fight against major killer diseases – tuberculosis, HIV and malaria.

Unit 1: Introduction to Microbiology(12 lectures)

1.1. History , application and Status of Microbiology in India.
1.2. Classification of Micro-organisms.
1.3. General features.
1.4. Microbial taxonomy- Bergey manual.

Unit 2: Structure and Diversity of Microorganisms. (12 lectures)

2.1. bacteriology- morphology and structure of Archaebacteria.
2.2. Structure and function of cell organelles of bacteria.
2.3. Structure of viruses.

Unit 3: Staining methods(12 lectures)

1.1. Stains and Dyes
1.2. Simple staining
1.3. Differential staining
1.4. Special staining

Unit 4: Microbial growth(12 lectures)

4.1. Growth curve-mathematical expression of growth.
4.2. Factors affecting microbial growth.
4.3. Batch, continuous, synchronous and diauxic growth
4.4. Quantification of growth.

Unit 5: Microbial Nutrition and metabolism. (12 lectures)

5.1. Nutritional classification of Microorganisms.
5.2. Concept of anabolism and catabolism process.
5.3. Nitrogen fixation- types and mechanism.
5.4. Microbial diseases in plants and animals.

Text /Reference Books:

1. Microbiology:Pelczar M J
2. Microbiology:Presscott L M,Harley J P and Klein D A
3. Textbook of Micrbiology-Ananthanarayan
4. General microbiology - Powar & Daginawala

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Usage of scientific terminologies to describe & express fundamental concepts in Microbiology.
2. Able to apply basic principles to understand host-microbe relationship in different Infectious diseases.
3. Able to connect and integrate the knowledge obtained for applications related to Microbes, their tools and database.
4. Able to connect and integrate the knowledge of microbiology and immunology from the perspective of a bioinformatician with special emphasis on microbe-immune interface

MCRB3011	**General Microbiology Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Monochrome Staining, Differential Staining, Gram Staining, and Acid Fast Staining and Romonowsky Staining
2. Special Staining Technique for Cell Wall, Capsule and Endospores and Fungal Staining, Lipid granules, metachromatic, flagella, spirochetes
3. Motility test
4. Sterilization of Laboratory Glassware and Media using Autoclave

5. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar
6. Isolation of Organisms , Macroscopic and microscopic studies: T-streak, Polygon method, Colony characteristics of microorganisms
7. Enumeration of microorganisms: Serial Dilution, Pour Plate, Spread Plate Method, Nephlometry, Haemocytometry, Breeds count
8. Growth Curve of E.coli
9. Effect of pH and temperature on growth of organisms

SEMESTER VI

Course Code	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BOTB6020	Plant metabolism	4	0	0	30	70	100	4
DSC	BOTB6010	Plant biotechnology	4	0	0	30	70	100	4
DSE	**	Discipline specific elective 3	4	0	0	30	70	100	4
DSE	**	Discipline specific elective 4	4	0/1	4/0	30	70	100	4
DSC	BOTB6021	Plant metabolism lab	0	0	4	15	35	50	2
DSC	BOTB6011	Plant biotechnology lab	0	0	4	15	35	50	2
DSE	**	Discipline specific elective 3 lab	0	0	4	15	35	50	2
DSE	**	Discipline specific elective 4 lab	0	1/0	0/4	15	35	50	2
		Total	**16**	**0**	**20**	**180**	**420**	**600**	**24**

BOTB6020	**PLANT METABOLISM**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To study different pathways including their biochemistry and to some extent the molecular details.
2. To understand regulation and integration of metabolic processes in plants with reference to crop productivity.
3. To understand significance of metabolic pathways for metabolic engineering in producing transgenics.
4. To gain the knowledge of physiological and biochemical processes in the plant system

Unit 1: Introduction

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).

Unit 2: Carbon assimilation (14 lectures)

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions,photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C_4pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 3: Carbohydrate metabolism (12 lectures)

Synthesis and catabolism of sucrose and starch Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle,amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron

transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 4: Lipid metabolism (8 lectures)

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Unit 5: Mechanisms of signal transduction (4 lectures)

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

Text /Reference Books:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.
   U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

3. Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Concept and significance of metabolic redundancy in plants
2. Students will also be able to learn the similarity and differences in metabolic pathways in animals and plants.
3. Understanding of water and nutrient uptake and movement in plants, role of mineral elements, translocation of sugars
4. Role of various plant growth regulatoras, phytochrome cytochromes and phototropins, and flowering stimulus.

BOTB6021	**PLANT METABOLISM LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.

4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

BOTB6010	**PLANT BIOTECHNOLOGY**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To apply relevant laboratory techniques for gene isolation, plant transformation and analysis of gene expression patterns in transgenic plants;
2. To realise the (im-)possibilities of the applications of plant biotechnology from a technical and societal point of view; -
3. To understand and be able to describe the general procedures of plant breeding programmes;
4. To explain different strategies to prevent, control and fight plant pests and diseases (chemical, biological, by cultivation, through (molecular) resistance breeding);
5. To understand the tools used for development of genetic, physical and sequence maps of prokaryotic and eukaryotic genomes, the relations between these maps and their specific application in genome mapping

2. Detailed Syllabus

Unit 1: Plant Tissue Culture (16 lectures)

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 2: Recombinant DNA technology (12 lectures)

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Unit 3:Gene Cloning (10 lectures)

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCRmediated
gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

Unit 4: Methods of gene transfer (8 lectures)

Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection,

Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 5: Applications of Biotechnology (14 lectures)

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops
with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Text /Reference Books:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Contributing towards developing high yielding and good quality crops to meet demands of the farmers and population
2. Contributing towards developing plants for bioremediation and sustaining in stressed climatic conditions
3. Start small scale companies with products that can cater to the agricultural sector
4. Carry out basic research in developing new products
5. Work in institutions and industries contributing to agribiotech sector

BOTB6011	**PLANT BIOTECHNOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Preparation of MS medium.
   Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of
   tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis &
   artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.

5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.Restriction digestion and gel electrophoresis of plasmid DNA.

LIST OF GENERAL ELECTIVE SUBJECTS

List of Generic Electives Available for students of B.Sc. (Hons.) BOTANY

Semester	Offering Department	Course Code (T+P)	Course Name	(L-T-P)	Credits
II	Biotechnology	BTEB2010+ BTEB2011	Introduction to Biotechnology	4-0-4	6
III	Biotechnology	BTEB3020+ BTEB3021	Immunology	4-0-4	6
IV	Biotechnology	BTEB4010+ BTEB4011	Pharmagenomics	4-0-4	6
II	Bioinformatics	BINB2010+BI NB2011	Introduction to Bioinformatics	4-0-4	6
III	Bioinformatics	BINB3010+ BINB3011	Concepts in Bioinformatics	4-0-4	6
IV	Bioinformatics	BINB4010+BI NB4011	Computer aided drug design.	4-0-4	6
I	Zoology	ZOOB1010+ ZOOB1011	Non-Chordates	4-0-4	6
II	Zoology	ZOOB2010+ ZOOB2011	Chordates	4-0-4	6
III	Zoology	ZOOB3010+ ZOOB3011	Animal Physiology: Controllong and coordinating system	4-0-4	6
IV	Zoology	BCHB4210+ BCHB4211	Biochemistry Of Metabolic Processes	4-0-4	6
II	Biochemistry	BCHB2020+ BCHB2021	Enzymes	4-0-4	6

III	Biochemistry	BCHB3020+ BCHB3021	Membrane Biology and Bioenergetics	4-0-4	6
IV	Biochemistry	BCHB4030+ BCHB4031	Hormone: Biochemistry and Function	4-0-4	6
II	Microbiology	MCRB2020+ MCRB2021	Bacteriology		
III	Microbiology	MCRB3030+ MCRB3031	Medical Microbiology	4-0-4	6
IV	Microbiology	MCRB4020+ MCRB4021	Food and Dairy Microbiology	4-0-4	6
I	Chemistry	CHYB1010 + CHYB1011	Inorganic Chemistry	4-0-4	6
II	Chemistry	CHYB2010 + CHYB2011	Organic Chemistry	4-0-4	6
III	Chemistry	CHYB3010 + CHYB3011	Physical Chemistry	4-0-4	6
IV	Chemistry	CHYB4010 + CHYB4011	Basic Analytical Chemistry	4-0-4	6

----------**BIOTECHNOLOGY**----------

BTEB2010	**INTRODUCTION TO BIOTECHNOLOGY**	**4L:0T:0P**	**4Credits**

COURSE OBJECTIVE

1. To study the different types of marine microorganisms, marine ecosystem
2. To study the use of marine organisms in production of drugs, enzymes, functional foods, nutraceuticals and cosmetics
3. To acquaint students with various fields of Biotechnology and their applications
4. To impart the knowledge of Healthcare and Food-Agri Biotechnology

Unit 1: History & Introduction to Biotechnology 12L

What is Biotechnology? Definition of Biotechnology, Traditional and Modern Biotechnology, Branches of Biotechnology-Plant, Animal Biotechnology, Marine Biotechnology, Agriculture, Healthcare,
Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental

Biotechnology. Biotechnology Research in India. Biotechnology Institutions I n India (Public and Private Sector)

Unit 2: Healthcare Biotechnology 12 L

Introduction, Disease prevention (Vaccines),types of vaccines,Disease Diagnosis, Detection of genetic diseases, Disease treatment, Drug designing, Drug delivery and targeting, Gene therapy

Unit 3: Food Biotechnology 12L

Biotechnological applications in enhancement of Food Quality Microbial role in food products Yeast, Bacterial and other Microorganisms based process and products Unit Operation in Food Processing, Food Deterioration and its Control.

Unit 4: Agriculture biotechnology 12L

GM Food, GM Papaya, GM Tomato, Fungal and Insect Resistant Plants Bt Crops, BT Cotton and BT brinjal, Golden Rice

Unit 5: Marine Biotechnology

Introduction to Marine Biotechnology, Bioprospecting, Methods for Microbial Bioprospecting in Marine Environments , Biotechnological Potential of Marine Microbes **,** Bioactive compounds from other Marine Organisms:fungi, Microalgae, Seaweeds, Actinomycetes, sponges

COURSE OUTCOME

1. Obtain clarity on the functioning of marine ecosystem
2. Elucidate on the use of marine organisms and their applications in industry
3. Define biotechnology and its growth over time
4. Enlist and explain its major applications and areas under research
5. Link major allied sciences to this field
6. Focus on major application areas of healthcare, food, beverage and drug industry
7. Enlist and distinguish its past and existing commercial products from major biotech industries

Text/ References

1) Biotechnology: Environmental Processes- Rehm and Reed- Wiley
2) Molecular Biotechnology- Glick and Pasterman ASM Press

BTEB2011	**INTRODUCTION TO BIOTECHNOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS

1. Introduction to Biotech lab.
2. Lab Equipments
3. Detection of food adulterants.
4. Study of marine organisms.

BTEB3020	Immunology	4L:0T:0P	4 Credits

COURSE OBJECTIVE

- To Understand of the overview of immune system including cells, organs and receptors.
- To learn structure and functions of different classes of immunoglobulins, the genetic basis of antibody diversity and the importance of humoral, cell-mediated and innate immune responses in combating pathogens.
- To understand mechanisms involved in different types of hypersensitivity, and the importance of conventional vs.recombinant vaccines.
- To get acquainted with the importance of antigen-antibody interaction in disease diagnosis.
- To understand the principles of tolerance, autoimmunity and the role of immunity in protection against pathogens**.**

Unit 1 Introduction to Immunology (12 lectures)

Immune Response - An overview, components of mammalian immune system Molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Unit 2 Immunoglobulin regulation (12 lectures)

Regulation of immunoglobulin gene expression – clonal selection theory, Allotypes & idiotypes, allelic exclusion immunologic memory, Heavy chain gene transcription, genetic basis of antibody diversity, Hypotheses (germ line & somatic mutation), antibody diversity.

Unit 3. MHC(12 lectures)

Major Histocompatibility complexes – class I & class II MHC antigens, Antigen processing.

Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

Unit 4. Immunotechniques (12 lectures)

Antigen antibody interaction techniques- Precipitation Reactions: Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis Agglutination Reactions: Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests. Synthesis of Monoclonal antibodies & Applications.

Unit 5 DNA Vaccines (12 lectures)

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents,Passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA

COURSE OUTCOME

- Students will be able to understand and apply basic microbiological techniques and correlate them with their fundamental concepts in the subject.
- Students will be able to understand and apply basic immunological techniques and correlate them with their fundamental concepts in the subject.

Text/ Reference Books

1. Kuby immunology, Judy Owen, Jenni Punt, Sharon Stranford., 7th edition (2012), Freeman and Co., NY
2. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
3. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
4. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
5. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
6. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
7. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publications.

BTEB3021	Immunology Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Passive Agglutination- RA Factor Test.
8. ELISA (Kit based).
9. Dot ELISA
10. Single radial immunodiffusion
11. Ouchterlony double immunodiffusion

BTEB4010	PHARMAGENOMICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To understand different antimicrobial agents
2. To learn the general principles of pharmacology
3. To understand the concept of toxicology
4. To study the mechanism of drug absorption and distribution
5. To understand basic and regulatory toxicology

Detailed Syllabus:

Unit I- Chemotherapeutic agents

Discovery and Design of antimicrobial, Classification of Antibacterial agents, Selective toxicity, MIC, MLC, Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin Injury to plasma membrane: Polymyxin, Inhibition of protein synthesis: Aminoglycosides, Tetracyclines, Chloramphenicol, Macrolides Erythromycin, Inhibition of nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole, Antimetabolites: Sulphonamides, Trimethoprim Drug resistance: Mechanism origin, transmission, Use and misuse of antimicrobial agents, Antifungal drugs, Antiviral drugs.

Unit 2 General principles of pharmacology

Mechanism of drug action , drug receptors and biological responses second-messenger systems, the chemistry of drug–receptor binding, dose–response relationship: therapeutic index, ED, LD, Potency and Intrinsic Activity, Drug antagonism

Unit 3 Drug Absorption and distribution

Absorption of drugs from the alimentary tract, factors affecting rate of gastrointestinal absorption, absorption of drugs from lungs and skin , absorption of drugs after parenteral administration factors influencing drug distribution , binding of drugs to plasma proteins, Physiological barriers to drug distribution

Unit 4 Basic and regulatory toxicology

Background Definitions Causation: degrees of certainty Classification, Causes Allergy in response to drugs, Effects of prolonged administration: chronic organ toxicity , Adverse effects on reproduction Poisons: Deliberate and accidental self-poisoning, Principles of treatment Poison-specific measures General measures , Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, herbicides and pesticides, biological substances (overdose of medicinal drugs is dealt with under individual agents**)**, Incapacitating agents: drugs used for torture, Nonmedical use of drugs

Text /Reference Books:

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
2. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition
3. Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition Elsevier
4. Biochemistry Metzler, D.E Elsevier
5. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill
6. Medical Microbiology Jawetz,E., Brooks,G.E, Melnick,J.L., Butel,J.S Adelberg E. A 18th edition
7. Medical Microbiology by Patrick Murray 5th edition

8. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown
9. Understanding Viruses by Teri Shors
10. Mim's Medical Microbiology 5th edition
11. Casarett & Doull's Toxicology- The Basic Science Of Poisons

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Elucidate the concepts of pharmacology
2. Comment on causes of allergic reactions with response to drug or poison
3. Obtain clarity about mechanism of absorption of drugs from different tissues
4. State the mechanism of action of different antimicrobials

BTEB4011	**PHARMAGENOMICS LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Antibiotic sensitivity test using agar cup method
2. Antibiotic sensitivity test using paper disc method
3. Antibiotic sensitivity test using ditch method.
4. Synergistic action of two drugs
5. LD 50, ED 50 evaluation using suitable models

----------MICROBIOLOGY----------

MCRB2020	**BACTERIOLOGY**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To provide in-depth knowledge of bacterial cell structure, its cultivation, growth and reproduction.
2. To gives insight into bacterial diversity and its significance.
3. To give hands on training of basic and very important bacteriological techniques which will give the student a strong base in microbiology

Detailed Syllabus:

Unit 1 Bacteriological techniques Lectures: 5

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit 2 Microscopy Lectures: 6

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 3 Reproduction in Bacteria Lectures: 3

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 4Bacterial Systematics Lectures: 8

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

Unit 5 Important archaeal and eubacterial groups Lectures: 16

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)] Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: Gram Negative: Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples

Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples Gram Positive: Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples Cyanobacteria: An Introduction

Text /Reference Books:

1. Atlas RM. (1997). Principles of Microbiology.
2. 2nd edition. WM.T.Brown Publishers. 2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. **(2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited**

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Will gain knowledge about morphology, structure and organisation of different cell components and be able to differentiate between cell walls of Gram positive and Gram-negative bacteria, cell walls and cell membranes of archaea and eubacteria.
2. Will also be able to explain gram and acid-fast staining reactions and effect of antibiotics and enzymes on cell wall structure.
3. Will get familiar with various techniques used for isolation, cultivation and preservation of different types of bacterial cultures. Will gain insight into working and importance of compound microscope.
4. understand nutritional requirements of different types of bacteria and formulation of media for bacterial growth.
5. Will be able to briefly explain methods of asexual reproduction in bacteria. Will understand different phases of growth curve and be able to define generation time and growth rate.
6. Can define and differentiate various types of classifications. Will gain insight into techniques used in polyphasic bacterial taxonomy.
7. Will get acquainted with differences between archaea and eubacteria and can list their important general characteristics along with ecological significance and economic importance.

MCRB2021	**BACTERIOLOGY**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

MCRB3030	**MEDICAL MICROBIOLOGY**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To introduce and acquaint the students with the key aspects of medical microbiology related to the diverse microbial pathogens, their virulence mechanisms, diagnostic methods and brief outline of the functional aspects of antimicrobial chemotherapy.

2. To deals with the recent development of new molecular diagnostic methods and the global spread and re-emergence of infectious diseases.

Detailed Syllabus:

Unit 1 Normal microflora of the human body and host pathogen interaction Lectures: 8

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 Sample collection, transport and diagnosis Lectures: 5

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes).

Unit 3 Bacterial diseases Lectures: 15

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Respiratory Diseases: Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis Gastrointestinal Diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficie

Unit 4 Viral diseases Lectures: 14

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit 5 Protozoan and Fungal diseases Lectures: 5

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous

mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

Text /Reference Books:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition**,** University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Will have gained an in depth knowledge about the spectrum of diseases caused by bacterial pathogens, and an understanding of the course of disease development and accompanying symptoms.
2. Will become familiar with the methods of transmission, epidemiological aspects as well as prevention and control methods.
3. Will become acquainted with the spectrum of diseases caused by viral pathogens. Also will understand the course of disease development and symptoms seen in diseases of different organ systems.
4. Will understand the causation of fungal and protozoal diseases and methods of prevention and control.
5. Will learn about the current approaches to diagnosis of diseases.

MCRB3030	**MEDICAL MICROBIOLOGY LAB**	**0L:0T:4P**	**2 Credits**

SUGGESTIVE LIST OF EXPERIMENTS:

1. Identify bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes,

chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)

7. Study of various stages of malarial parasite in RBCs using permanent mounts.

MCRB4020	FOOD AND DAIRY MICROBIOLOGY	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. to acquaint students with the role of microorganisms in association with foods, highlighting both their beneficial and harmful activities and their applications in the food industry
2. to understand the concept of quality control of food.

Detailed Syllabus:

Unit 1 Foods as a substrate for microorganisms Lectures: 8

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various foods Lectures: 10

Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods

Unit 3 Principles and methods of food preservation Lectures: 12

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 4 Fermented foods Lectures: 10

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) Lectures: 10

Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni

Text /Reference Books:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.

2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Will be aware of the possible sources of contamination of foods and the parameters affecting microbial growth in foods.
2. Will gain insight into the microbial spoilage of some foods
3. Will acquire an in-depth knowledge of various physical and chemical methods used for food preservation.
4. Will be acquainted with microbial production of fermented dairy and non-dairy food products.
5. Will also be able to understand the health benefits of prebiotics, probiotics and synbiotics.
6. Will be conversant with some food-borne diseases and will be able to explain methods for detection of food borne pathogens.

MCRB4021	**FOOD AND DAIRY MICROBIOLOGY LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.

4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

----------BIOINFORMATICS----------

BINB2010	**INTRODUCTION TO BIOINFORMATICS**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To Learn and understand basic concepts of Bioinformatics
2. To understand various databases.
3. To learn and understand protein databases.
4. To understand nucleic acid databases.
5. To learn about genomic databases.

Unit 1: Introduction (12 Lectures)

1.1. Definition ,History , branches , scope and research areas in Bioinformatics

1.2. Human genome project

1.3. Role of computer in bioinformatics

1.4. Applications and BIO-IT

Unit 2: Introduction to databases (12 Lectures)

2.1. Introduction to genomics and proteomic data, post genomic era.

2.2. Data acquisition- functions and purposes.

2.3. Biological databases- relational and object oriented concepts.

2.4. Information retrieval from biological databases- ENTREZ and SRS.

2.5. Methods for presenting large quantities of data- sequence and strucrure viewer

Unit 3: Introduction to Nucleic acid Databases (12 Lectures)

3.1. Primary and secondary database, genebanks.

3.2. EVBC nucleotide, sequence data bank-DDBJ.

3.3. RNA sequence databases: 16S & 23S rRNA, mutation databases, HIV sequence database.

3.4. NON CODE sequence submission tools- Sequin, Webin , Sakura, bankIT.

Unit 4: Protein Sequence Databases (12 Lectures)

4.1. Protein Sequence Databases- PIR, SWISSPORT, UNIPORT, EMBL,EXPASY, NCBI MIPS.

4.2. Motiff databases- eblocks, PROSITE

4.3. Protein domain databases-ADDA, INTERPRO, Pfam.

Unit 5: Structural Databse (12 Lectures)

5.1. PDB, PDB sum, CATH/SCOP,MMDB, SWISS- MODEL.

5.2. Repository ModBase, Protein Model Portal.
5.3. Eurocarb DB, DIP, BIND, STRING.

Text /Reference Books:

2. Orpita basu & Sinninder kaur, Thakural ,"Bioinformatics databases tools, Alogrithm, 2007, Oxford University Press.
3. Higgins D, Willie Taylor " Bioinformatics, Sequence, Structure and data bank, A practical approach, 2000, First edition, Oxford University Press.

Allwood T, david Parry Smith; Introduction to bioinformatics, 2008, Pearson education, Singapore

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Gain an understanding of the basic concepts of Bioinformatics and Biostatistics
2. Understand the tools used in Bioinformatics.
3. Apply the various Statistical tools for Analysis of Biological Data

BINB2011	**INTRODUCTION TO BIOINFORMATICS LAB**	**0L:0T:4P**	**4 Credits**

LIST OF EXPERIMENTS:

1. To explore NCBI.
2. To explore gene bank.
3. To explore PDB.
4. To perform sequence alignment using BLAST.
5. To access the SCOP and CATH databse to study protein classification.
6. To visualize protein using Rasmol.
7. To explore STRING database.

BINB3010	**CONCEPTS IN BIOINFORMATICS**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. List the concepts and applications of sequence searching
2. Define the concepts of homology, identity, orthologues, paralogues
3. Provide examples of basic sequence alignment, introducing concepts of point mutations, deletions, insertions etc.
4. Provide an outline of the different approaches to sequence alignment - exhaustive vs. heuristic

Detailed Syllabus:

Unit 1: Introduction (12 lectures)

1.2. Introduction, Sequence alignment
1.3. Scoring Matrix- PAM and BLOSUM
1.4. Gaps and Gap penalties
1.5. Different types of Gap weights and Application of Gaps**.**

Unit 2: Alignments (12 lectures)

2.1. Pairwise alignment: DotPlot analysis.

2.2. Dynamic programming- Needleman- Wunch Algorithm, Smith- Waterman algorithm, Edit distance dynamic program ming.

2.3. Clusrtal W, TCOFFEE, Profile methods- Gribskov profile, PSI_BLAST

2.4. Multiple segment alignment- sum of pairs, Divide and conquer, Progressive and Iterative alignment

Unit 3: Cluster detection (12 lectures)

3.1. Phylogenetic relationships, Clustering and Phylogeny

3.2. Phylogenetic analysis- concept of Phylogenetic tree, Methods of Phylogeny analysis- Diastance and character based methods.

3.3. Motif detection

3.4. Protein family databases.

Unit 4: Data Mining(12 lectures)

4.1. Data Mining- introduction and definition.

4.2. Data Mining problem and Data Mining Techniques, Tools and Methods.

4.3. Management of databases.

4.4. DBMS. Difference between DBMS and file system.

Unit 5 Metabolomics (12 lectures)

5.1. metabolic pathway database (KEGG pathway database)

5.2. Concept of Metablome and Metabolomics

5.3. Drug discovery and Design- target identification, target validation, lead identification, lead optimization, Priclinical Pharmacology and Toxicology.

5.4. Chemoinformatics tools for drug discovery- Chemical structure representation(SMILE & SMART), Chemical datatbases (CSD,ACD,WDI, PUBCHEM and Chembank)

Text /Reference Books:

1. Orpita basu & Sinninder kaur, Thakural ,"Bioinformatics databases tools, Alogrithm, 2007, Oxford University Press.
2. Higgins D, Willie Taylor " Bioinformatics, Sequence, Structure and data bank, A practical approach, 2000, First edition, Oxford University Press.
3. Allwood T, david Parry Smith; Introduction to bioinformatics, 2008, Pearson education, Singapore.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Extract and generate pairwise sequence alignments for a protein sequence of interest
2. Describe and interpret the metrics used to assess the quality of a pairwise sequence alignment, identity versus similarity
3. Describe the differences between homologues, paralogues and orthologues

4. Use a pairwise sequence approach to identify mutations between two sequences

BINB3011	CONCEPTS IN BIOINFORMATICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

2. To perform sequence alignemt using clustal W.
3. To study phylogenetic relationship using PHYLIP/MEGA.
4. To find motif using motif search.
5. To explore pathway database: KEGG database.

BINB4010	COMPUTER AIDED DRUG DESIGN.	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To design potential lead molecules against any disease that may be explored further as a potential candidate for the drug development.
2. To learn QSAR and SAR
3. To understand the concept of molecular docking
4. To learn the details of molecular modeling

Unit 1: Introduction to Drug Discovery and Development (12 lectures)

1.1.Stages of drug discovery and development

1.2. Lead discovery and Analog Based Drug Design Rational approaches to lead discovery based on traditional medicine,

1.3. Random screening, Non-random screening, serendipitous drug discovery, lead discovery based on drug metabolism, lead discovery based on clinical observation.

1.4. Analog Based Drug Design: Bioisosterism, Classification, Bioisosteric replacement. Any three case studies

Unit 2: QSAR and SAR (12 lectures)

2.1.Quantitative Structure Activity Relationship (QSAR)

2.2. SAR versus QSAR, History and development of QSAR,

2.3. Types of physicochemical parameters, experimental and theoretical approaches for the determination of physicochemical parameters such as Partition coefficient, Hammet's substituent constant and Tafts steric constant. Hansch analysis, Free Wilson analysis, 3D-QSAR approaches like COMFA and COMSIA.

Unit 3: Molecular docking (12 lectures)

3.1. MolecularModelingandVirtual Screening techniques: Drug likeness screening,

3.2. Concept of pharmacophore mapping and pharmacophore based Screening,

3.3. Molecular docking: Rigid docking, flexible docking, manual docking, Docking based screening.

3.4. *De novo* drug design.

Unit 4: Informatics (12 lectures)

4.1.Informatics & Methods in drug design
4.2. Introduction to Bioinformatics, chemoinformatics.
4.3. ADME databases, chemical, biochemical and pharmaceutical databases.

Unit 5: Molecular Modeling (12 lectures)

5.1. Molecular Modeling: Introduction to molecular mechanics and quantum mechanics.
5.2. Energy Minimization methods and Conformational Analysis,
5.3. Global conformational minima determination.

Text /Reference Books:

1. Advanced Concepts in Structural Bioinformatics: Structural Bioinformatics: Philip E. Bourn (Editor), HelgeWeissig (Editor). ISBN: 978-0-471-20199-1
2. Protein Structure Prediction: A Practical Approach (The Practical Approach Series , No 170) by Michael J. E. Sternberg
3. Computer-aided Drug Design: Practical Application of Computer-Aided Drug Design (Hardcover) by Charifson (Author)
4. Computer-Aided Drug Design. Methods and Applications. Edited by Thomas J. Perun and C. L. Propst Marcel Dekker

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Feasibility study of a drug development project
2. Design and optimize lead molecules against drug target, andusing ligand-basedapproach
3. Determination of pharmacophore from lead molecules and active sites and use of pharmacophore for lead discovery
4. Development of potential drug molecule and pharmacophore databases for virtual screening
5. Use of molecular fragments for lead discovery and implementation of statistical approaches for lead molecule discovery

BINB4011	**COMPUTER AIDED DRUG DESIGN. LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Installation of various drug design software and assignment 'Project'
2. Generation of 3D optimized structure of a "Ligand" molecule
3. Preparation of target and ligand molecules for docking
4. Virtual library Preparation" of lead molecules
5. Docking of ligands into a receptor (active site)
6. Flexible docking of ligand with target
7. Fragment docking using '*De Novo'* Receptor and '*De Novo'* Links (LUDI algorithm)
8. Pharmacophore modeling of ligands
9. Pharmacophore-based database searching and *de novo* design of ligand against an active site
10. Development of 3D QSAR model by using "Discovery Studio"
11. ADME property and toxicity predictions of lead molecule (usingTOPKAT)

----------BIOCHEMISTRY----------

BCHB2012	**ENZYMES**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life,
2. To develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation.
3. To outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Unit 1 Enzyme kinetics Lectures: 10

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver- Burk plot, Eadie-Hofstee and Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme.

Unit 2 Bisubstrate reactions Lectures: 2

Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Unit 3 Enzyme inhibition and Mechanism of action of enzymes Lectures: 8

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues.

Unit 4 Regulation of enzyme activity Lectures: 8

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen. Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit 5 Involvement of coenzymes in enzyme catalysed reactions and Applications of enzym

TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.

Text /Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-42 92-3414-8.
2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

Course Outcomes:

At the end of this course :

1. Students will learn the nature and importance of enzymes in living systems
2. Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity

3. Students will learn about the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
4. Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
5. students will learn applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

BCHB2021	**ENZYMES LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Partial purification of acid phosphatase from germinating mung bean.
2. Assay of enzyme activity and specific activity, e.g. acid phosphatase.
3. Effect of pH on enzyme activity
4. Determination of Km and Vmax using Lineweaver-Burk graph.
5. Enzyme inhibition - calculation of Ki for competitive inhibition.
6. Continuous assay of lactate dehydrogenase.
7. Coupled assay of glucose-6-phosphate dehydrogenase

BCHB3020	**MEMBRANE BIOLOGY AND BIOENERGETICS**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. Knowledge of membrane composition, structure-function relationship and properties.
2. Understanding of mechanism of membrane transport
3. Knowledge of basics of Bioenergetics and mechanisms of oxidative phosphorylation and photophosphorylation

2. Detailed Syllabus:

Unit 1 Introduction to biomembranes and Membrane Strucures Lectures: 4

Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems. Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.

Unit 2 Membrane dynamics Lectures: 6

Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Unit 3 Membrane transport Lectures: 10

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins**.** Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactosepermease, Na+-glucose symporter. ABC family

of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Unit 4 Introduction to bioenergetics Lectures: 6

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Unit 5 Oxidative phosphorylation Lectures : 12

Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.

Text /Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641- 0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the general composition and structure of biomembranes.
2. Understand the basic properties of membranes such as membrane fluidity.
3. Have knowledge about the various types of membrane transport mechanisms.
4. Understand the basic tenets of Bioenergetics.
5. Understand the concept of chemiosmotic theory and the mechanism of Oxidative phosphorylation and ATP synthesis.
6. Understand the basic mechanisms of photophosphorylation in plants and microbes

BCHB3021	MEMBRANE BIOLOGY AND BIOENERGETICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O2 evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.

BCHB4030	HORMONE: BIOCHEMISTRY AND FUNCTION	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

6. To provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response.
7. To imparts an understanding of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function

Detailed Syllabus:

Unit 1 Introduction to endocrinology Lectures : 6

Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology.

Unit 2 Hormone mediated signaling Lectures : 16

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP3, DAG, Ca2+, NO. Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin, erythropoietin receptor; ras - MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk.

Unit 3 Hypothalamic and pituitary hormones Lectures : 8

Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.

Unit 4 Thyroid hormone Lectures : 4

Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimato's disease.

Unit 5 Hormones regulating Ca2+ homeostasis Lectures : 6

PTH, Vitamin D and calcitonin. Mechanism of Ca2+ regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Text /Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (NewYork), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-09621.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893300-6.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand and appreciate the different cognate and non-cognate modes of communication between cells in a multi-cellular organism
2. Understand the role of endocrine system in maintaining ionic and glucose homeostasis
3. Should be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.
4. Understand the integrative communications that regulate, growth, appetite, metabolism and reproduction

BCHB4031	**HORMONE: BIOCHEMISTRY AND FUNCTION LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Glucose tolerance test.
2. Estimation of serum Ca2+.
3. Estimation of serum T4.
4. Estimation of serum electrolytes.
5. Case studies

----------ZOOLOGY----------

ZOOB1010	**NON-CHORDATES : PROTISTS TO ECHINODERMATA**	**4L:0T:0P**	**4Credits**

Course Objectives:

1. To understand different levels of biological diversity through the systematic classification of invertebrate fauna
2. To understand the taxonomic position of protozoa to echinodermatas.
3. To understand the general characteristics of animals belonging to protozoa to echinodermatas.
4. To understand the body organization of phylum from protozoa to echinodermatas.
5. To understand the origin and evolutionary relationship of different phylum from protozoa to to echinodermata.

Unit 1: Protista, Parazoa and Metazoa 12 lectures

1.1.General characteristics and Classification up to classes
1.2.Study of *Euglena*, *Amoeba* and *Paramecium*
1.3.Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*
1.4. Locomotion and Reproduction in Protista

Unit 2: Porifera and Cnidaria 12 lectures

2.1.General characteristics and Classification up to classes
2.2. Canal system and spicules in sponges
2.3. General characteristics and Classification up to
classes and Metagenesis in *Obelia*
2.4. Polymorphism in Cnidaria
2.5. Corals and coral reefs

Unit 3: Helmimthes, Platyhelminthes and Annelida 12 lectures

3.1.General characteristics and Classification up to classes
3.2. Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*

Unit 4: Arthropoda 12 lectures

4.1. General characteristics and Classification up to classes
4.2. Type study of palamaneous
4.3. Type study of periplata
4.4. Insect and vectorsof human diseases.

Unit 5 Mollusca and Echinodermata 12 lectures

5.1. General characteristics and Classification up to classes
5.2. Mollusca –type study of prawn
5.3. Echinodermata – study of star fish.
5.4. Minor Phyla- Ectophora and rotifera

Course Learning Outcomes: The course will enable the students to learn the following:

1. Student should be able to describe unique characters of protozoa to echinodermata
2. Student should be able to recognize life functions of protozo to echinodermata

3. To recognise the ecological role of phylum protozoa to echinodermata
4. **T**o recognise the diversity from protozoa to echinodermata

Text /Reference Books:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

ZOOB1011	Non Chordates Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in protista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella, Spongilla*
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*
5. One specimen/slide of any ctenophore
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/micro-photographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

ZOOB2010	CHORDATES	4L:0T:0P	4 Credits

COURSE OBJECTIVES

1. To understand what the chordates are.
2. To understand different categories of chordates.
3. To understand the general characters of chordates.
4. To understands the level of organization in chordate subphylum.
5. To understand the origin and evolutionary relationship in different subphylum of chordates.

UNIT 1:

1.1. General characters of Chordata
1.2 Prochordata
1.2.1 Salient features of Cephalochordata
1.2.2 Structure of Branchiostoma
1.2.3 Affinities of Cephalochordata
1.2.4 Salient features of Urochordata
1.2.5 Structure and life history of Herdmania
1.2.6 Significance of Retrogressive metamorphosis

Unit – 2:

2.1 Cyclostomata
2.1.1 General characters of Cyclostomata
2.1.2 Comparision of the Petromyzon and Myxine
2.2 Pisces
2.2.1 General characters of Fishes
2.2.2 Classification of fishes up to sub - class level with examples
2.2.3 Scoliodon - External features, Digestive system, Respiratory system, Heart, Brain
2.2.4 Migration in Fishes
2.2.5 Types of Scales

Unit – 3:

3.1 Amphibia
3.1.1 General characters of Amphibian
3.1.2 Classification of Amphibia upto orders with examples.
3.1.3 Rana hexadactyla - External features, Digestive system, Respiratory system, Heart, Brain
3.2 Reptilia
3.2.1 General characters of Reptilia
3.2.2 Classification of Reptilia upto orders with examples
3.2.3 Calotes - External features, Digestive system, Respiratory system, Heart, Brain
3.2.4 Identification of Poisonous snakes and Skull in reptiles

Unit :4 Aves

4.1 General characters of Aves
4.2. Classification of Aves upto subclasses with examples.
4.3 Columba livia - External features, Digestive system, Respiratory system, Heart, Brain
4.4 Migration in Birds
4.5 Flight adaptation in birds

Unit -5 Mammalia

5.1 General characters of Mammalia
5.2 Classification of Mammalia upto sub - classes with examples
5.3 Comparision of Prototherians, Metatherians and Eutherians
5.4. Dentition in mammals

COURSE OUTCOME

1. Student should be able to describe unique characters of urochordates, cephalochordates and fishes.
2. Student should be able to recognize life functions of urochordates to fishes.
3. To understand the ecological role of different groups of chordates.
4. To understand the diversity ofchordates

Text Books/ Reference Books

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.

2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

ZOOB2011	Chordates Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS

1. Protochordata : Herdmania, Amphioxus, Amphioxus T.S. through pharynx
2. Cyclostomata : Petromyzon, Myxine
3. Pisces : Pristis, Torpedo, Channapleuronectes, Hippocampus, Exocoetus, Eheneis, Labeo, Catla, Clarius, Auguilla,Protopterus Placoid scale, Cycloid scale, Ctenoid scale
4. Amphibia : Ichthyophis, Amblystoma, Siren, Hyla, Rachophous Axolotl larva
5. Reptilia : Draco, Chemaeleon, Uromastix, Vipera russeli, Naja, Bungarus, Enhydrina, Testudo, Trionyx, Crocodilus
6. Aves : Passer, Psittacula, Bubo, Alcedo, Columba, Corvus, Pavo,
7. Study of different types of feathers : Quill, Contour, Filoplume down
8. Mammalia : Ornithorthynchus, Tachyglossus, Pteropus, Funambulus, Manis, Loris, Hedgehog Osteology : Appenducular skeletons of Varanus, Pigeon Rabbit - Skull, fore limbs, hind limbs and girdles

ZOOB3010	ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEM	4L:0T:0P	4 credits

COURSE OBJECTIVE

1. To know about the functioning of various system of organisms and their interrelationship for well-coordinated function.
2. To understand structure and functions of different animal tissues and endocrine glands

Unit 1: Tissues

1.1. Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

1.2. Bone and Cartilage Structure and types of bones and cartilages, Ossification, bone growth and resorption

Unit 2: Nervous System

2.1. Structure of neuron, resting membrane potential,

2.2. Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers;

2.3. Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc;

2.4. Physiology of hearing and vision.

Unit 3: Muscle Histology of different types of muscle;

3.1. Ultra structure of skeletal muscle;

3.2 Molecular and chemical basis of muscle contraction;

3.3. Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 4: Reproductive System

4.1. Histology of testis and ovary;

4.2. Physiology of male and female reproduction; Puberty,

4.3. Methods of contraception in male and female

Unit 5 : Endocrine System

5.1. Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action;

5.2. Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones;

5.3. Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones

COURSE OUTCOME

1. Should be able to recognize and explain how all physiological systems work in unison to maintain homeostasis in the body and use of feedback loops to control the same i.e., should learn about an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body. e.g. Cardiovascular and Respiratory systems to meet the oxygen demand of the body.
2. Synthesize ideas to make connection between knowledge of physiology and real world situations, including healthy life style decisions and homeostatic imbalances i.e. how physiological mechanisms adapt in response to various external and internal stimuli in order to maintain health.
3. Knowledge of role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes

TEXT / REFERENCE BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

ZOOB3011	**Animal Physiology: Controlling and coordinating system**	**0L:0T:4P**	**2Credits**

LIST OF EXPERIMENTS

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues (*Subject to UGC guidelines)

BCHB4210	**Biochemistry Of Metabolic Processes**	**4L:0T:0P**	**4 Credits**

COURSE OBJECTIVES

1. To understand The relationship between the structure and function of specific biological molecules and enzymes are regulated
2. To understand main principles of metabolic biochemistry concepts and homeostasis is controlled in the body
3. To understand function of specific anabolic and catabolic pathways and how these pathways are controlled and interrelated
4. To Understand the metabolism of carbohydrates and fates of various intermediate and end products

Unit 1: Overview of Metabolism

1.1 Catabolism vs Anabolism, Stages of catabolism,

1.2. Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions;

1.3. Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

2.1. Sequence of reactions and regulation of glycolysis, Citric acid cycle,

2.2. Phosphate pentose pathway,

2.3. Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism

3.1. β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms;

3.2.Biosynthesis of palmitic acid;

3.3. Ketogenesis

Unit 4: Protein Metabolism

4.1. Catabolism of amino acids: Transamination, Deamination,

4.2. Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation

5.1.Redox systems; Review of mitochondrial respiratory chain,
5.2.Inhibitors and un-couplers of Electron Transport System

COURSE OUTCOME

1. Students gain knowledge and skill in the interactions and interdependence of physiological and biomolecules and the understand essentials of the metabolic pathways along with their regulation.
2. To understand the principles, instrumentation and applications of bioanalytical techniques.
3. To expose the students to various processes used in industries.
4. Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation and be able to design and conduct scientific experiments and analyze the resulting data.

Text/ Reference Books

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

BCHB4211	**Biochemistry Of Metabolic Processes Lab**	**0L:0T:4P**	**2Credits**

LIST OF EXPERIMENTS:

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

----------CHEMISTRY----------

CHYB1010	**Inorganic Chemistry**	**4L:0T:0P**	**4 Credits**

Course Learning Objectives:

The objective of this course is:

1. To make student learn about wave mechanics.

2. To study about periodic properties of S,P,D & F block elements
3. To impart knowledge of covalent and ionic bond.
4. To impart knowledge of metallic bonds and weak Chemical Forces
5. To make student learn about oxidation and reduction.

Unit 1: **Atomic Structure:** L:14

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit 2: **Periodicity of Elements:** L:16

s, *p*, *d*, *f* block elements, the long form of periodic table. Properties of the elements with reference to *s*&*p*-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) Ionic and crystal radii. Covalent radii (octahedral and tetrahedral) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Pauling's/ Mulliken's/Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

Unit 3: **Chemical Bonding I:** L:16

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and

dipole moment.

Unit 4: **Chemical Bonding II:** L:10
Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Unit 5:**Oxidation-Reduction:** L:4
Redox equations, Standard Electrode Potential and its application to inorganic reactions.

Text/Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Course Outcomes:

At the end of this course students will be able to:

1. Understand the concept of wave mechanics.
2. Know the variations of periodic properties in S, P, D and F block elements.
3. Have knowledge of different types of bond nature.
4. Understand the weak chemical forces interactions.
5. To solve problems related to oxidation and reduction.

CHYB1010	**Inorganic Chemistry Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To have knowledge of calibration of different glassware's.
2. To prepare different normal and molar solution.
3. To have knowledge of acid base reaction.
4. To Estimate free alkali present in different soaps/detergents.
5. Understand concept of oxidation and reduction based reactions.

CHYB2010 Organic Chemistry 4L:0T:0P 4 Credits

Course Learning Objectives:

The objective of this course is:
1. To impart knowledge of hybridization, Electronic Displacements reactions.
2. To make students learn about chemistry of alkanes.
3. To make students understand carbon-carbon pi bonds.
4. To impart knowledge of cycloalkanes and conformational Analysis.
5. To make students understand aromatic character of cyclic compounds.

Unit 1: **Organic Compounds:** L: 16

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.
Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocation's, Carbanion, Free radicals and Carbenes.
Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit 2: **Carbon-Carbon sigma bonds::**L: 8
Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Unit 3: **Carbon-Carbon pi bonds::**L: 14
Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.
Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylicbromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.
Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit 4: **Cycloalkanes and Conformational Analysis** : L: 10
Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Unit 5: **Aromaticity:** L: 12
Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Text/Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Apply the knowledge of hybridization and molecular displacements in molecular modeling.
2. Learn the preparation and properties of alkanes.
3. Have knowledge of chemical reactions of alkenes and alkynes.
4. Understand the concept of Conformation analysis of alkanes.
5. Understand concept of aromaticity.

CHYB2011 Organic Chemistry Lab 0L:0T:4P 2 Credits

LIST OF EXPERIMENTS:

1. Checking the calibration of the thermometer

2. Purification of organic compounds by crystallization using the following solvents:

a. Water
b. Alcohol
c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)

4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To purify organic compounds by crystallization.
2. To determine the melting points of unknown organic compounds.
3. To determine mixed melting point of two unknown organic compounds
4. To determine boiling point of liquid compounds.
5. Separate a mixture of various compounds by the help of chromatography.

CHYB3010 Physical Chemistry 4L:0T:0P 4 Credits

Course Learning Objectives:

The objective of this course is:

1. To impart knowledge of phase and binary solutions.
2. Students will learn about molecularity, rate laws and kinetics of complex reactions.
3. To gain knowledge of collision theory of reaction rates and temperature dependence of reaction rates.
4. To impart knowledge of enzyme catalysis.
5. To make students learn about surface chemistry.

Unit 1: **Phase Equilibria:** L:28

Concept of phases, components and degrees of freedom, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, two and three component systems. *Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit 2: **Chemical Kinetics I:** L:10

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Unit 3: **Chemical Kinetics II:** L:8

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit 4: **Catalysis:**L:8

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit 5: **Surface chemistry:**L:6

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

Text/Reference Books:

- Peter Atkins & Julio De Paula, *Physical Chemistry*9^{th} *Ed.*, Oxford University Press (2010).
- Castellan, G. W. *Physical Chemistry*, 4^{th} Ed., Narosa (2004).

- McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).

- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics*. CRC Press: NY (2011).
- Zundhal, S.S. *Chemistry concepts and applications*Cengage India (2011).
- Ball, D. W. *Physical Chemistry*Cengage India (2012).
- Mortimer, R. G. *Physical Chemistry3rd Ed.*, Elsevier: NOIDA, UP (2009).
- Levine, I. N. *Physical Chemistry6th Ed.*, Tata McGraw-Hill (2011).
- Metz, C. R. *Physical Chemistry2nd Ed.*, Tata McGraw-Hill (2009).

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Students will learn about phase equilibria and binary solutions.
2. Will have idea of molecularity and rate laws.
3. Students will have idea about collision theory of reaction rates.
4. Students will understand about enzyme catalytic reaction.
5. Solve problems related to surface chemistry.

CHYB3011 Physical Chemistry Lab 0L:0T:4P 2 Credits

LIST OF EXPERIMENTS:

I. Determination of critical solution temperature and composition of the PHBEnol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
simple eutectic and
congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

V. Study the kinetics of the following reactions.
1.Initial rate method: Iodide-persulphatereaction 2.Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption
Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Text/Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
- Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry3rd Ed.;* W.H. Freeman & Co.: New York (2003).

CHYB4010	Basic Analytical Chemistry	4L:0T:0P	4 Credits

Course Learning Objectives:

The objective of this course is:

1. To introduce students about analytical chemistry and its concept.
2. To impart knowledge of analysis of soil and water.
3. To make students study about food products and preservatives.
4. To make students learn about chromatography and constituents of cosmetics.
5. To study the use spectrophotometer and flame photometer for performing different experiments.

Unit 1: **Introduction:** L: 5

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Unit 2: **Analysis of soil and water:** L: 7 Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators
Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Unit 3: **Analysis of food products**: L:6
Nutritional value of foods, idea about food processing and food preservations and adulteration.
Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

Unit 4: **Analysis of preservatives and colouring matter:** L: 6
Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible). Analysis of cosmetics: Major and minor constituents and their function. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by Complexometric titration.

Unit 5: **Suggested Applications(Any one):** L:6
To study the use of PHBEnolphthalein in trap cases.
To analyze arson accelerants.
To carry out analysis of gasoline.
Suggested Instrumental demonstrations:
Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Text/ Reference Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog &Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.

10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To develop the knowledge of analytical chemistry.
2. To analyse composition and concepts of soil and water.
3. To understand some food products and identification of some common food items.
4. To develop the knowledge of ion exchange chromatography.
5. Handle flame photometer and spectrophotometer.

CHYB4011	Basic Analytical Chemistry Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Determination of pH of soil samples.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample.
4. Determination of dissolved oxygen (DO) of a water sample.
5. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
6. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
7. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
8. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Generic Electives offered by Department of BOTANY for students in B.Sc. (Hons.) in Allied Programmes

Semester	Course Code	Generic Electives	(L-T-P)	Credits
I	MCRB1010+MCRB1011	Microbiology and Phycology	4-0-2	6
I	BINB1020+BINB1021	Biomolecules and Cell Biology	4-0-2	6
II	BOTB2010+BOTB2011	Diversity of Archaegoniates&Plant Anatomy	4-0-2	6

II	BOTB2020+BOTB2021	Plant physiology and Ecology	4-0-2	6
III	BOTB3010+BOTB3011	Anatomy of Angiosperms	4-0-2	6
III	BOTB3020+BOTB3021	Economic botany	4-0-2	6
III	BOTB3030+BOTB3031	Reproductive biology	4-0-2	6
IV	BTEB4030+BTEB4031	Molecular biology	4-0-2	6
IV	BOTB4010+BOTB4011	Phytogeography	4-0-2	6
IV	BOTB4020+BOTB4021	Plant systematics	4-0-2	6

*** Detailed Syllabus for these courses are the same as the courses of the same names and codes offered as DSC courses of the B.Sc. (Hons.) BOTANY Programme**

List of Discipline Specific Elective Papers: (Credit: 06 each)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
V	BOTB5310+BOTB5311	Analytical Techniques In Plant Sciences	4-0-2	6
V	BINB5320+BINB5321	Bioinformatics	4-0-2	6
V	BSCB5010+BSCB5011	Stress biology	4-0-2	6
VI	BOTB6330+BOTB6331	Plant breeding	4-0-2	6
VI	BOTB6320+BOTB6321	Natural resource management	4-0-2	6

VI	BOTB6310	Horticultural Practices	5-1-0	6

BOTB5310	**ANALYTICAL TECHNIQUES IN PLANT SCIENCES**	**4L:0T:0P**	**4 Credits**

Course Learning Objective:

The objectives of this course are:

1. To describe various imaging related techniques;
2. To give an overview of the principle of spectrophotometry and its application in biological research;
3. To characterize proteins and nucleic acids;
4. To analyze statistical data and perform chi-square test for goodness of fit

Detailed Syllabus

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 and Spectrophotometry (4 lectures)

Principle and its application in biological research.

Use in biological research, auto-radiography, pulse chase experiment.

Unit 4: Chromatography (8 lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 5 : 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

Text /Reference Books:

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,
4. K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
5. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop conceptual understanding of cell wall degradation enzymes and cell fractionation.
2. Classify different types of chromatography techniques.
3. Explain the principles of Light microscopy, compound microscopy, Fluorescence microscopy and confocal microscopy
4. Apply suitable strategies in data collections and disseminating research findings.

BOTB5311	**ANALYTICAL TECHNIQUES IN PLANT SCIENCES LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

BINB5320	**BIOINFORMATICS**	**4L:0T:0P**	**4 Credits**

Course Learning Objective:

The objectives of this course are:

1. To learn and understand basic concepts of Bioinformatics
2. To learn about protein and nucleic acid databases**.**
3. To Understand the concept of databases and use of different public domain for DNA and proteins sequence retrieval.
4. To Understand the concept of pairwise alignment of DNA sequences using algorithms.

Deta 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 and Applications of Bioinformatics (8 Lectures)

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of databases and use of different public domain for DNA and proteins sequence retrieval.
2. Understand the concept of pairwise alignment of DNA sequences using algorithms.
3. Explain the structure of proteins homology modeling approach using SWISS MODEL and SWISS-PDB.
4. Reflect upon the role of various models in molecular evolution.
5. Analyze the role of (QSAR) techniques in Drug Design

Reference Books:

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

BINB5321	BIOINFORMATICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree

BSCB5010	STRESS BIOLOGY	4L:0T:0P	4 Credits

Course Learning Objective:

The objectives of this course are:

1. To illustrates knowledge of stress adaptations in biological systems.
2. To deliver molecular understanding of primary and secondary metabolic process.
3. To present perspectives of the current tools for application in biological system for biotechnological research.
4. To Demonstrate the concept using different activities for building capacity.

Detailed Syllabus

Unit 1: Defining plant stress (2 lectures)

Acclimation and adaptation.

Unit 2: Environmental factors (20 lectures)

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit 3: Stress sensing mechanisms in plants (20 lectures)

Calcium modulation, Phospholipid signaling

Unit 4: Developmental and physiological mechanisms that protect plants against environmental stress (12 lectures)

Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.

Unit 5: Reactive oxygen species–Production and scavenging mechanisms. (6 lectures)

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop the understanding of concept of stress, stress factors and resistance mechanisms.
2. Explain different types of stress with examples.
3. Develop the ability for critical appraisal of various physiological mechanisms that protect the plant from environmental stress i.e. adaptation, avoidance and tolerance.
4. Analyze the role of production and scavenging mechanisms

Reference Books:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

BSCB5011	STRESS BIOLOGY	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Zymographic analysis of peroxidase.
4. Zymographic analysis of superoxide dismutase activity.
5. Quantitative estimation and zymographic analysis of catalase.

6. Quantitative estimation and zymographic analysis of glutathione reductase.
7. Estimation of superoxide anions.

BOTB6330	PLANT BREEDING	4L:0T:0P	4 Credits

Course Learning Objective:

The objectives of this course are:

1. To identify characteristics of self- and cross-pollinated plants
2. Identify sources of genetic variation to conduct a breeding program
3. Determine breeding methodology appropriate for plants with different mating systems
4. Conduct basic statistical analyses related to plant breeding

Detailed Syllabus

Unit 1: Plant Breeding (10 lectures)

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 2: Methods of crop improvement (20 lectures)

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 3: Quantitative inheritance (10 lectures)

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings.Monogenic vs polygenic Inheritance.

Unit 4: Inbreeding depression and heterosis (10 lectures)

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 5: Crop improvement and breeding (10 lectures)

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.
2. Familiarize with genetic basis of heterosis.
3. Classify Sexual and Asexual modes of reproduction.
4. Explain monogenic and polygenic inheritance
5. Reflect upon the **role of various non- conventional methods used in crop improvement**

Reference Books:

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th.

2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing

BOTB6331	PLANT BREEDING LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

BOTB6320	NATURAL RESOURCE MANAGEMENT	4L:0T:0P	4 Credits

Course Learning Objective:

The objectives of this course are:

1. To present students, regardless of their disciplinary background, with an overview of the interdisciplinary aspects of sustainable natural resource management.
2. To discuss concepts and principles related to the economic, environmental, social, cultural and ethical considerations of resource management, and evaluate different methods of balancing these sometimes competing interests in order to manage resources sustainably.
3. To examine global natural resource issues and international collaborative efforts to address them, through the lens of sustainable development

Detailed Syllabus

Unit 1: Natural resources (2 lectures)
Definition and types.
Unit 2: Sustainable utilization (8 lectures)
Concept, approaches (economic, ecological and socio-cultural).
Unit 3: Land and Water (8 lectures)
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.
Unit 4: Biological Resources (12 lectures)
Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting;
IPR; CBD; National Biodiversity Action Plan).
Unit 5: Forests (6 lectures)
Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of different natural resources and their utilization.
2. Critically analyze the sustainable utilization land, water, forest and energy resources.

3. Evaluate the management strategies of different natural resources.
4. Reflect upon the different national and international efforts in resource management and their conservation

Reference Books

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

BOTB6321	NATURAL RESOURCE MANAGEMENT LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

BOTB6310	HORTICULTURAL PRACTICES	5L:1T:0P	6 Credits

Course Objective:

The objectives of this course are:

1. To Understand the concept of different types of horticultural crops, their conservationand management
2. Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants.
3. To Critically evaluate different cultivation practices and disease management
4. To Reflect upon different Landscaping practices and garden design

Detailed Syllabus

Unit 1: Introduction (4 lectures)

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

Unit 2: Ornamental plants (4 lectures)

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).

Unit 3: Fruit and vegetable crops (4 lectures)
Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

Unit 4: Horticultural techniques (8 lectures)
Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

Unit 5: Landscaping and garden design (6 lectures)
Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Course Outcomes:
At the end of this course students will demonstrate the ability to:

1. Understand the concept of different types of horticultural crops, their conservation and management
2. Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants.
3. Critically evaluate different cultivation practices and disease management
4. Reflect upon different Landscaping practices and garden design

Reference Books:

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

List of Skill Enhancement Course (any Two, 1 in each Sem III & Sem IV) (Credit: 02 each)

Semester	Course Code	Course Name	(L-T-P)	Credits
III	BOTB3210	Biofertilizers	2-0-0-	2
III	BOTB3220	Herbal technology	2-0-0-	2
III	BOTB3230	Nursery & Gardening	2-0-0-	2

IV	BOTB4210	Floriculture	2-0-0-	2
IV	BOTB4230	Medicinal botany	2-0-0	2
IV	BOTB4220	Forensic botany	2-0-0	2

BOTB3210	**BIOFERTILIZERS**	**2L:0T:0P**	**2 Credits**

Course Objective:

The objectives of this course are:

1. To understand the basics of biofertilizers and their cultivation
2. To study about mycorrhiza and their isolation and production
3. To impart knowledge on pesticides and their control by biopesticides, including their production and commercialization

Detailed Syllabus

Unit 1: Biofertilizers (4 lectures)

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2: . Azotobacter **(8 lectures)**

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

Unit 3: Cyanobacteria .(4 lectures)

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation

Unit 4: VAM (6 lectures)

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.

Unit 5: Organic farming (6 lectures)

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.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Develop their understanding on the concept of bio-fertilizer
2. Identify the different forms of biofertilizers and their uses
3. Compose the Green manuring and organic fertilizers
4. Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).
5. Interpret and explain the components, patterns, and processes of bacteria for growth in crop production

Reference Books:

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

BOTB3220	HERBAL TECHNOLOGY	2L:0T:0P	2 Credits

Course Objective:

The objectives of this course are:

1. To understand the importance of the medicinal plant wealth in India and the role of Medicinal plants in human health care.
2. To know the medicinally useful plants, Herbal medicine preparation for common diseases and adulterants**.**

Unit 1:Herbal medicines. (6 Lectures)

history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants

Unit 2:Pharmacognosy .(6 Lectures)

-systematic position m edicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka

Unit 3:Phytochemistry –(6 Lectures)

active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).**)**

Unit 4:Analytical pharmacognosy: (8 Lectures)

Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

Unit 5:Medicinal plant (4 Lectures)

banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy

COURSE OUTCOME

1. Develop their understanding on Herbal Technology
2. Define and describe the principle of cultivation of herbal products.
3. List the major herbs, their botanical name and chemical constituents.
4. Evaluate the drug adulteration through the biological testing
5. Formulate the value added processing / storage / quality control for the better use of herbal medicine
6. Develop the skills for cultivation of plants and their value added processing / storage / quality control

Reference Books

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.

2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book _Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH _publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

BOTB3230	NURSERY & GARDENING	2L:0T:0P	2 Credits

Course Objective:

1. To Develop an understanding of nursery business management (financial, marketing, personnel).
2. To Develop skills necessary to manage a wholesale nursery.
3. To Acquire knowledge regarding theory and practice of cultural and production techniques and methods.

Unit 1:Nursery: .(4 Lectures)

definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants

Unit 2: **Seed: (6 Lectures)**

Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

Unit 3: Vegetative propagation(6Lectures)

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

Unit 4:Gardening: (8 Lectures)

definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

Unit 5:Sowing/raising of seeds and seedlings – (6 Lectures)

Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, andcarrots - Storage and marketing procedures.

COURSE OUTCOME

1. Understand the process of sowing seeds in nursery
2. List the various resources required for the development of nursery
3. Distinguish among the different forms of sowing and growing plants
4. Analyse the process of Vegetative propagation
5. Appreciate the diversity of plants and selection of gardening
6. Examine the cultivation of different vegetables and growth of plants in nursery and gardening

Reference Books:

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
1. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
2. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
3. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
4. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and
5. Cooperation, National _Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

BOTB4210	FLORICULTURE	2L:0T:0P	2 Credits

Course Objective:

1. To have knowledge of gardening and cultivation of ornamental plants
2. To have knowledge of landscaping, and soil condition.
3. To make the flower arrangement.

Unit 1: . (2 Lectures)

Introduction: History of gardening; Importance and scope of floriculture and landscape Gardening

Unit 2: (8 lectures)

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.

Unit 3: (4 lectures)

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.

Unit 4: . (4 lectures)

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**Unit 5:**Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit 5: (6 lectures)

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).

COURSE OUTCOME

1. Develop conceptual understanding of gardening from historical perspective
2. Analyze various nursery management practices with routine garden operations.
3. Distinguish among the various Ornamental Plants and their cultivation
4. Evaluate garden designs of different countries
5. Appraise the landscaping of public and commercial places for floriculture.
6. Diagnoses the various diseases and uses of pests for ornamental plants

Reference Books

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

BOTB4230	MEDICINAL BOTANY	2L:0T:0P	2 Credits

Course Objective:

1. To recognize the basic medicinal plants
2. To apply techniques of conservation and propagation of medicinal plants.
3. To Setup process of harvesting, drying and storage of medicinal herbs
4. To Propose new strategies to enhance growth of medicinal herbs considering the practical issues pertinent to India

Unit 1: Medicinal plants (10 Lectures)

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

Unit 2: Consevation of medicinal plants **(10 Lectures)**

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

Unit 3: Ethnobotany and Folk medicines (10 Lectures)

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.

Course outcome

1. Know about history and relevance of herbal drugs in Indian system of medicine
2. Learn the macroscopic and microscopic characters, chemical constituents, adulterants, therapeutical and pharmaceutical uses of medicinal plants

Reference Books

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.

BOTB4220	FORENSIC BOTANY	2L:0T:0P	2 Credits

Course Objective:

1. To define forensic botany
2. To identify disciplines related to forensic biology, including palynology and limnology
3. To demonstrate an understanding of how forensic biology is used to influence legal outcomes
4. To demonstrate an understanding of information sources related to forensic biology

Unit I

General plant classification schemes, Sub specialization of forensic botany- plant

morphology, plant anatomy, plant systematic, palynology, plant ecology, limnology, Plant architecture- roots, stems, flowers, leaves. Practical plant classification schemes: - vegetables and herbs, fruits bearing trees and plants, landscaping plants: trees, shrubs and vines, grasses, plant cell structure and functions.

Unit II

Various types of woods, timbers, seeds and leaves and their forensic importance, Identification and matching of various types of wood, timber varieties, seeds and leaves. Types of fibers – forensic aspects of fiber examinations, Identification and comparison of man–made and natural fibres. Various types of Planktons and diatoms and their forensic importance, Study and identification of pollen grains, Identification of starch grains, powder and stains of spices etc. Paper and Paper Pulp identification

Unit III

Various types of poisonous plants-*Abrus precatorius, Aconitum, Anacardium occidentale, Argemone Mexicana, Calotropis, Cannabis sativa, Claviceps purpuria, Cinchona, Croton tiglium ,Atropa belladonna, Erythroxylum coco, Gloriosa superb, Jatropha curcas, Lathyrus sativus, Manihot utilissima, Nerium indicum, Nicotiana tabacum, Plumbago, Ricinus communis, Semicarpus anacardium, Strychnos nux vomica, Thevetia nerifolia*, Types of plants yielding drugs of abuse – opium, cannabis, coco, tobacco, dhatura, *Psilocybin* mushrooms.

Unit IV

Collection and preservation of botanical evidences: Botanical samples, outdoor crime scene consideration, Analysis of samples, DNA analysis, plant DNA typing, Classic forensic botany cases: Case histories by using Plant anatomy and systematic, Palynology.

Course outcomes

After completing this course, the learner will be able to:

1. Conceptualize classification of plants from forensic point of view.
2. Understand forensic importance of different parts of plants.
3. Collect and preserve botanical evidences of crime and analyze classic and DNA based forensic botany cases.

Reference Books:

1) Coyle H M (2004) Forensic Botany: Principles and Applications to Criminal
2) Casework. CRC Press.
3) James S.H., Nordby J.J., Bell S. (2015). Forensic Science: An Introduction to
4) Scientific and Investigative Techniques. CRC Press; 4 edition.
5) Hall D W and Byrd J (2012) Forensic Botany: a practical guide. Wiley-Blackwell,
6) 1edition.
7) Bock J H and Nrris D O (2016) Forensic Plant Sciences.

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