

# **MOUNT CARMEL COLLEGE, AUTONOMOUS**

No. 58, Palace Road, Bengaluru, India - 560 052



**MOUNT CARMEL COLLEGE  
AUTONOMOUS  
BENGALURU**

**Syllabus for M.Sc. Life Science  
Choice Based Credit System (CBCS)  
2020 – 2022**

## **M.Sc Life Science**

### ***Program outcomes***

1. The program provides in-depth knowledge about concepts, principles and processes in basic branches of Biology.
2. It provides an integrated approach to applied areas of Biological Science.
3. Students acquire knowledge in emerging areas in health care - symptoms, diagnosis and treatment.
4. Enables the student to appreciate Biodiversity, conservation and importance of environmental sustenance.
5. Helps the student to understand the working principle of laboratory instruments and emerging techniques and their applications.
6. Students acquire the required skills in handling scientific instruments, planning and performing laboratory experiments and draw logical inferences.
7. Develops communication skills, scientific writing and data analysis which will help in expressing ideas with clarity.
8. Develops a scientific temperament in the students and stresses the importance of ethical practices.
9. Imbibe professional ethics and moral values in the work - place and social life.
10. Enables the students to integrate the curriculum to life requirements and empower them to be efficient teachers and researchers.

### Course Matrix for Batch 2020-2022

Sl. No.	Course Code	Title	LTP	Credits
<b>I Semester</b>				
1	CC-01	Core Course – I Animal and Plant Diversity	3:0:4	5
2	CC-02	Core Course – II Biomolecules	3:0:4	5
3	CC-03	Core Course – III Cell Biology	3:0:4	5
4	CC-04	Core Course – IV Genetics	4:2:0	5
5	AC-01	Allied Course – I Biostatistics	2:0:0	2
6	AC-02	Allied Course – II Instrumentation and Lab Techniques	2:0:0	2
		<b>Total</b>		<b>24</b>
<b>II Semester</b>				
1	CC-05	Core Course – V Basic Microbiology	3:0:4	5
2	CC-06	Core Course – VI Human Physiology	3:0:4	5
3	CC-07	Core Course – VII Plant Physiology	3:0:4	5
4	CC-08	Core Course – VII Immunology	4:2:0	5
5	AC-03	Allied Course – III Research Methodology	2:0:0	2
6	AC-04	Allied Course – IV Environmental Science	2:0:0	2
7		Community Development Programme		2
		<b>Total</b>		<b>26</b>
<b>III Semester</b>				
1	EC-01	Elective Course I – DSE Applied Microbiology	3:0:4	5
2	EC-02	Elective Course II – DSE Molecular Biology	3:0:4	5

3	EC-03	Elective Course III / CHOICE Human Endocrinology and Reproductive Biology Or Plant Developmental Biology and Plant Diseases	3:0:4	5
4	EC-04	Elective Course IV / CHOICE Animal Tissue Culture or Plant Tissue Culture	4:2:0	5
5	AC-05	Allied Course – V Bioinformatics	2:0:0	2
6	OE	Open elective Pet Behaviour and Care	2:0:0	2
7		Internship Report		2
		<b>Total</b>	<b>31</b>	<b>26</b>
<b>IV Semester</b>				
1	EC-05	Elective Course V/ OPTION Clinical Biochemistry or Food and Fermentation Technology	3:0:4	5
2	EC-06	Elective Course VI/ OPTION Economic Biology or Evolution and Ethology	4:2:0	4
3	EC-07	Elective Course VII – DSE r – DNA Technology	4:0:0	5
4	PR-01	Project / Viva Voce	12	8
				22
		<b>Total credits</b>		<b>98</b>

## SEMESTER-I

### CC 01: Animal and Plant Diversity

45 hrs

#### Objectives:

- To be familiar with different nonchordate and chordate phyla. To know the general and distinguishing characters of each of them and to understand how the different systems evolved in their complexity.
- To appreciate the vast diversity of plant life on earth. To understand the basics of plant classification and become familiar with various systems of plant classification. To classify plants based on morphological characters.

#### Course Outcomes

**CO1:** Describing the body diversity, special features and adaptive characters of invertebrates

**CO2:** Discuss the roles and relationships between animals and their environment.

**CO3:** Demonstrate knowledge of adaptive characteristics and interesting features of major vertebrate animal groups.

**CO4:** Understand the basis of Bentham and Hooker's system of classification. Learn the rules of the International Code of Botanical Nomenclature.

**CO5:** Gain knowledge of the characteristic features of a few dicotyledonous families of plants.

**CO6:** Learn the interesting features of some plants belonging to Monocot families.

#### Details

<b>UNIT 1</b>	<b>Invertebrate form and function -1</b>	<b>Hrs 07</b>
	Protozoa – Diversity in unicellular body form, intracellular digestion, locomotion and reproduction – conjugation and its significance	3
	Porifera – Body form, water canal system	2
	Coelenterata – Polymorphism with suitable examples	1
	Helminthes –Parasitic adaptations	1
<b>UNIT 2</b>	<b>Invertebrate form and function -2</b>	<b>Hrs 06</b>
	Annelida – Parasitic adaptations in leech	1
	Arthropoda –Diversity in body form, Social organization in termite and bee, Hormonal control of metamorphosis	2
	Mollusca - Diversity in body form and types of shells	1
	Echinodermata – Diversity in body form and water vascular system	1
	Prochordates - General characters and classification with examples.	1
<b>UNIT 3</b>	<b>Vertebrate form and function</b>	<b>Hrs 10</b>
	Fishes –swimming adaptations, migration –catadromous and anadromous	2
	Amphibia- Parental care, hormonal control of metamorphosis	2

	Reptiles-Adaptations, identification of venomous and non-venomous forms, poison apparatus	2
	Aves- Flight adaptation, nesting diversity, migration	2
	Mammals- Interesting features of marsupials, proboscidae, cetaceans, chiroptera and communication in monkeys.	2

### Plant Diversity

<b>Unit - 4</b>	<b>Plant taxonomy</b>	<b>Hrs 06</b>
	Definition, scope and objectives; Taxonomic hierarchy; classification of Engler and Prantl	2
	Plant nomenclature-ICBN ranks, basis, rules, typification, principles of priority, effective and valid publication, citation and rejection of names and terminologies.	2
	Current trends in Biosystematics; Botanical inventories, Flora and monographs.	2
<b>UNIT – 5</b>	<b>Study of families with plants of medicinal/economic importance: - 1</b>	<b>Hrs 10</b>
	Archichlamydeae – Myrtaceae, Rutaceae, Papilionaceae	5
	Metachlamydeae – Asteraceae, Apocynaceae, Rubiaceae and Labiatae	5
<b>Unit - 6</b>	<b>Study of families with plants of medicinal/economic importance: - 2</b>	<b>Hrs 06</b>
	Metachlamydeae – Euphorbiaceae	2
	Monocotyledonae- Zingiberaceae and Musaceae	4

### References:

1. Invertebrate Zoology – P S Verma and E L Jordan
2. Chordate Zoology - P S Verma and E L Jordan
3. Taxonomy of Angiosperms – B. P. Pandey
4. Taxonomy of Angiosperms - Sambamurthy

## Plant Diversity PRACTICALS

Unit No	Title	Hrs
1	Plant Systematics and Preparation of dichotomous key	4
2	Plant Systematics - Archichlamydeae	4
3	Plant Systematics - Metachlamydeae	4
4	Plant Systematics - Metachlamydeae	4
5	Plant Systematics - Monocotyledonae	4

## ANIMAL DIVERSITY PRACTICALS

Unit No	Title of practicals	Hrs
1	Porifera Specimen-Leucosolenia, Sycon, Euspongia, Spongilla	4
2	Coelenterata Hydra, Obelia, Physalia, Aurelia, Sea anemone, Corals	4
3	Helminthes Liver fluke, Tape worm, Ascaris Annelida Earthworm, Leech, Nereis, Chaetopterus	4
4	Arthropoda Peripatus, Scorpion, Praying mantis, Butterfly, Silk moth, Honey bee	4
5	Mollusca Unio, Octopus; Shell - Dentalium, Nautilus Echinodermata Starfish, Sea urchin, Sea lily.	4
6	Fishes Scoliodon, Sting ray, Hammer head shark, Exocetus Hippocampus	4
7	Amphibia Rana, Hyla, Rhacophorus, Salamander, Necturus, Ichthyophis Reptiles Naja, Hydrophis Viper, Dryophis	4
8	Birds Feet and beak modification in Hawk, King fisher, Duck, Parrot Mammals Rabbit, Mangoose, Hedgehog, Bat	4
9	Prefinal examination	4

**CC 02: Biomolecules****45 hrs****Objectives:**

- *To understand the molecular architecture and building blocks of cellular components and its biological significance*

**Course Outcomes**

**CO1:** Learn the structures, functions and metabolism of carbohydrates.

**CO2:** Elucidation of protein structure and its interactions, its isolation and purification.

**CO3:** Understand the protein and amino acid metabolism.

**CO4:** Demonstrate knowledge of lipids and its functional role and metabolism.

**CO5:** Appreciate the synthesis and metabolism of nucleotide.

**Details:**

<b>UNIT 1</b>	<b>Carbohydrates</b>	<b>Hrs 08</b>
	Importance of carbohydrates. Structure, properties and importance of homo and hetero-polysaccharides	3
	Structure and functions of blood group and bacterial polysaccharides	1
	Structure and functions of glycosaminoglycans, cardioglycosides and glycoproteins	1
	Lectins –their characteristics and functions in biological systems	1
	General methods of structure elucidation of carbohydrates (chemical methods – methylation, graded degradation by acid hydrolysis, periodate oxidation method)	2
<b>UNIT 2</b>	<b>Carbohydrate metabolism</b>	<b>Hrs 05</b>
	Glycolysis, fermentation reaction, glycogenesis, glycogenolysis, citric acid cycle	3
	Hexose monophosphate shunt, gluconeogenesis	2
<b>Unit 3</b>	<b>Proteins</b>	<b>Hrs 08</b>
	Peptide bond, naturally occurring peptides, ionic properties of peptides and proteins	2
	Isolation and purification of proteins	1
	Primary structure: elucidation of primary structure of proteins, determination of amino acid composition, end sequencing	2
	Secondary structure: alpha helical, beta pleated sheet and triple helical structures Ramachandran plot	1
	Tertiary structure and forces involved in stabilization of tertiary and quaternary structure	1
<b>UNIT 4</b>	<b>Protein and amino acid metabolism</b>	<b>Hrs 04</b>
	General aspects of amino acid metabolism	2
	Urea cycle and disorders	1
	Uric acid biosynthesis	1
<b>Unit 5</b>	<b>Amino acid catabolism</b>	<b>Hrs 04</b>
	Catabolism of tyrosine, phenylalanine, tryptophan	2



	Sulphur-containing amino acids - creatine and creatinine	2
<b>UNIT 6</b>	<b>Lipids</b>	<b>Hrs 04</b>
	Classification, brief account of the chemistry (without structure elucidation)	1
	Biological roles - fatty acids, acyl glycerols, phospholipids	2
	Sphingolipids (cerebrosides and gangliosides), steroids (cholesterol and bile acids)	2
<b>UNIT 7</b>	<b>Lipid metabolism</b>	<b>Hrs 07</b>
	Biosynthesis of fatty acids, biosynthesis of phospholipids, biosynthesis of triacylglycerol.	3
	Synthesis, transport and excretion of cholesterol	2
	Oxidation of fatty acids $\alpha$ , $\beta$ and $\omega$ , Ketogenesis,	1
<b>UNIT 8</b>	<b>Nucleotide metabolism</b>	<b>Hrs 05</b>
	Phosphodiester method of synthesis, <i>De novo</i> synthesis of purine and pyrimidine	3
	Regulation in nucleotide biosynthesis, degradation of nucleic acids	2

### References:

1. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).
3. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
4. Complex Carbohydrates, Sharon, N. Addison Wisely, (1975).
5. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).
6. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
7. Principles of Biochemistry; Smith et al., McGarw Hill (1986).
8. Proteins Structures and Molecular Properties 2nd Edn. Thomas E. Creighton, W H Freeman and Co. (1993).
9. Principles of Protein Structure, Function, & evolution, Dickerson & Geis 2nd Ed. Benjamin-Cummings (1983).
10. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).

## BIOMOLECULES PRACTICALS

Unit No	Title of the Practicals	Hrs
1	Estimation of reducing sugar by DNS method.	4
2	Estimation of total carbohydrates by Anthrone method.	4
3	Estimation of protein by Folin–Ciocalteu method	4
4	Determination of iodine value of a lipid.	4
5	Determination of saponification value of oil or fat.	4
6	Estimation of Inorganic phosphate by Fiske-Subbarow method.	4
7	Estimation of titrable acidity of urine.	4
8	Estimation of cholesterol in serum by Zak's method.	4
9	Determination of protein content by UV spectroscopy (A280)	4
10	Prefinal	4

**CC 03: Cell Biology****45 hrs****Objectives:**

- To appreciate the cell as a basic unit of life and learn the structure and functions of various cell organelles. To understand various cellular processes like cell signaling, cell transport and cell division.

**Course Outcomes**

**CO1:** Get an in-depth knowledge of the cell as a basic unit of life. Learn the ultra-structure and functions of various cell organelles.

**CO2:** Understand the various transport mechanisms of the cell.

**CO3:** Learn various aspects of cell signaling. Appreciate the importance of communication between cells and various cell receptors. Gain knowledge about secondary messengers and cell signaling pathways.

**CO4:** Understand the process of mitosis and meiosis. Learn the importance of chromosomes in the process of cell division.

**CO5:** Study the role of cyclins and protein kinases in regulating the cell cycle as well as the importance of cell cycle check points.

**CO6:** Understand the mechanism and importance of programmed cell death.

**Details**

<b>UNIT 1</b>	<b>Cell and its constituents –I</b>	<b>Hrs 05</b>
	Cytoplasm -its constitution and functions; importance of biological water, cell matrix	2
	Ultra - Structure and functions of cell organelles - cell wall, plasma membrane, cytoskeleton, nucleus, chromosomes and nucleosome concept	3
	<b>Cell and its constituents - II</b>	<b>Hrs 05</b>
	Ultra - structure and functions of cell organelles - mitochondria, golgi complex, endoplasmic reticulum, vacuoles	3
	Lysosomes, centrosomes, plastids, endosomes, peroxisomes	2
<b>UNIT 2</b>	<b>Cell Transport</b>	<b>Hrs 07</b>
	Osmosis - endosmosis, exosmosis, role of aquaporins	1
	Diffusion -simple diffusion, facilitated diffusion (ion channels -calcium channel, hexose permease as glucose transporter, Na <sup>+</sup> -K <sup>+</sup> leak channels	2
	Active transport (Na <sup>+</sup> -K <sup>+</sup> pump, Ca <sup>2+</sup> -ATPase pump, proton pump, / uniport, symport and antiport transfer)	2
	Vesicular transport - Types of vesicles and their functions-exocytosis, endocytosis, transcytosis, pinocytosis and phagocytosis	2
<b>UNIT 3</b>	<b>Cell Signaling – I</b>	<b>Hrs 06</b>
	Communication between cells and their environment; Characters of cell signaling	2
	Inter cellular signaling (growth factors, differentiation signals, histamine receptors)	2

	Cell surface and intracellular signal receptors, role of selectins, integrins and cadherins in cell signaling	2
<b>UNIT 4</b>	<b>Cell Signaling – II</b>	<b>Hrs 06</b>
	Secondary messengers in cell signaling-G coupled receptors and their role, cAMP, hormones, neurotransmitters, nitric oxide as secondary messengers	2
	Cell signaling and adhesions in inflammation, host -parasite interaction and metastasis	2
	Outline of different signaling pathways	2
<b>UNIT 5</b>	<b>Cell Division and Cell Cycle -I</b>	<b>Hrs 05</b>
	Types of cell division, behavior of chromosomes during mitosis and meiosis, eukaryotic cell cycle; karyokinesis and cytokinesis, genetic recombination, non-disjunction of chromosomes and its significance	
<b>UNIT 6</b>	<b>Regulation of Cell Cycle -II</b>	<b>Hrs 05</b>
	Role of cyclins and protein kinases (CDKs and their interaction at various stages of mammalian cell cycle)	
	Kinase inhibitors and their role in regulation-check points for DNA damage	
<b>UNIT 7</b>	<b>Programmed Cell Death (PCD)</b>	<b>Hrs 06</b>
	Apoptosis pathways	1
	Causes and consequence of necrosis in different tissues and organ systems, Tumor necrotic factor	2
	Role of apoptosis in development and differentiation	1
	Regulation of apoptosis /programmed cell death: role of caspases, Bcl-2 receptors	2

#### References:

1. Cooper, G. M., (2000): The Cell – A Molecular Approach
2. Karp, G., Cell and Molecular Biology (6<sup>th</sup> Ed.)
3. Verma, P. S. and Agarwal, V. K.: Cell Biology, Genetics, Molecular Biology, Evolution and Ecology
4. Alberts, B., Johnson, A., Raff, M. and Walter, P. (2004): Molecular Biology of the Cell

## CELL BIOLOGY PRACTICALS

Unit No	TITLE OF THE PRACTICALS	Hrs
1.	Squash temporary slide preparation of onion root tip for the study of mitosis stages	4
2.	Squash temporary slide preparation of onion flower buds or <i>Rheo</i> flower or grasshopper testis for the study of meiosis stages.	4
3.	Preparation of buccal smear to observe mitochondria.  Study of root and shoot apical meristems - Permanent slides	4
4.	Study of different types of plant tissues-Parenchyma, Sclerenchyma, Collenchyma	4
5.	Study of different types of plant tissues- Xylem and Phloem	4
6.	Anatomy of monocot and dicot leaf, root and stem	
7.	Study of different types of animal tissues- Epithelial tissue, Muscle tissue	4
8.	Study of different types of animal tissues-, Connective Tissue- Bone, Cartilage and Blood	4
9.	Histology of tongue, stomach, intestine, liver and kidney	4
10.	Prefinals	4

**Objectives:**

- To understand the importance of the role of inheritance and inherited characters. To enable students to appreciate the role of genetics in medicine, animal and plant breeding. To study various gene interactions and the significance of linkage and crossing over. To understand the importance of chromosomal aberrations and their role in genetic studies.

**Course Outcomes**

**CO1:** Understand the various types of gene interactions and their effects on the phenotype.

**CO2:** Study the concepts involved in multiple allelism, sex-linked inheritance and pleiotropism.

**CO3:** Understand the concept of non-disjunction of chromosomes and its effects on the phenotype.

**CO4:** Gain knowledge about the various mechanisms of extra-nuclear inheritance.

**CO5:** Learn the mechanisms involved in the determination of sex in man and others organisms.

**CO6:** Comprehend various aspects of human genetics and their relevance in medicine.

**CO7:** Study the importance of genetics in plant breeding and its impact on agriculture.

**CO8:** Understand the concepts of linkage and crossing over and their significance.

**Details:**

<b>UNIT 1</b>	<b>Interaction of Genes and their Expression</b>	<b>Hrs 07</b>
	Combs in fowl; complementary genes (flower colour in sweet pea, deaf-mutism in man – 9:7 ratio); recessive epistasis (coat colour in rodents – 9:3:4 ratio); dominant epistasis (plumage colour in fowl – 13:3 ratio); atavism	5
	Quantitative Genetics (polygenic inheritance) - skin colour in man.	2
<b>UNIT 2</b>	<b>Allelism and Sex-Linked Inheritance</b>	<b>Hrs 08</b>
	Multiple alleles – A, B, O blood groups in man; Rh factor inheritance (erythroblastosis fetalis); self-sterility alleles ( <i>Nicotiana</i> ); pleiotropism.	4
	Inheritance of X-linked genes – Characters of X-linked inheritance (Examples: eye colour in <i>Drosophila</i> , colour blindness and hemophilia in man). Inheritance of Y-linked and X-Y linked genes; sex limited genes.	4
<b>UNIT 3</b>	<b>Chromosomal Aberrations</b>	<b>Hrs 07</b>
	Primary and secondary non-disjunction. Aneuploidy – types and effects of aneuploidy in man (autosomal and allosomal aneuploidy). Detection of Chromosomal aberrations	
<b>UNIT 4</b>	<b>Basis and mechanism, role of organellar genes.</b>	<b>Hrs 06</b>
	Extranuclear inheritance: a) Organelle heredity: Chloroplast-Variation in 4'o clock plant; Mitochondria- Petite in <i>Saccharomyces</i> , b) Maternal effect- Shell coiling in <i>Limnaea</i> ,)	3

	Cytoplasmic Inheritance - Paramecium (Kappa Particle), d) Infectious heredity - Sigma virus and Wolbachia bacterium in Drosophila.	3
<b>UNIT 5</b>	<b>Determination of Sex</b>	<b>Hrs 05</b>
	Chromosomal theory of sex determination; functions of X and Y chromosomes.	2
	Genic balance theory of sex determination in Drosophila; sex types in Drosophila (Gynandromorph and intersex).	2
	Sex determination in man and plants (Melandrium). Influence of hormones and environmental factors on sex determination (Examples: <i>Bonellia viridis</i> and free martins).	1
<b>UNIT 6</b>	<b>Human Genetics – Introduction to human genetics; human karyotyping; genetics of twins; human metabolic disorders (albinism, alkaptonuria, phenylketonuria, hemophilia, sickle cell anemia and thalassemia); Human Genome Project.</b>	<b>Hrs 06</b>
<b>UNIT 7</b>	<b>Genetics of Plant Breeding in Agriculture</b>	<b>Hrs 08</b>
	Inbreeding, outbreeding and heterosis (hybrid vigor). Its application in agriculture. Polyploidy – autopolyploidy and allopolyploidy; polyploidy in plants and its economic significance.	
<b>UNIT 8</b>	<b>Linkage and Crossing Over</b>	<b>Hrs 05</b>
	Linkage – Definition, types of linkage and its significance. Crossing over – Definition, types of crossing over and its significance	

**References:**

1. . Verma, P. S. and Agarwal, V. K.: Cell Biology, Genetics, Molecular Biology, Evolution and Ecology
2. Gardner : Principles of Genetics
3. Snustad and Simmons: Principles of Genetics
4. Sinnott, Dunn and Dobzhansky: Principles of Genetics

**Genetics (Tutorials)**

<b>Unit No.</b>	<b>Title of the practicals</b>	<b>Hours</b>
1.	Genetics-problems	2
2.	Genetics-problems	2
3.	Genetics-problems	2
4.	Genetics-problems	2
5.	Karyotyping human chromosomes -G and V banding- staining	2
6.	Developing pedigree charts	2
7.	Study of Drosophila mutants	2
8.	Chromosomal aberrations-charts	2
9.	Chromosome maps for human syndromes-charts	2
10.	Prefinals	2



## **BIOSTATISTICS**

### **I Sem M.Sc. Food Science and Nutrition/Human Development/Life Science/Plant Science and Herbal Wealth**

#### **UNIT I**

**5 hours**

Types of data, summarization of data through frequency distributions, histograms, bar diagrams. Measures of central tendency – mean, median, mode. Measures of dispersion – Range, Variance, Standard Deviation, Coefficient of Variation.

#### **UNIT II**

**8 hours**

PROBABILITY – basic rules, unconditional and conditional probability, independence. Random variables – discrete and continuous. Binomial, Poisson and normal distributions. Probability: Randomization, Normal distribution, Normally distributed population and probability, standard normal distribution, measures of deviation from the normal distribution – skewness and kurtosis, types of skewness, Karl-Pearson's coefficient of skewness, types of kurtosis.

#### **UNIT III**

**8 hours**

Testing of Hypothesis – population, sample, random sample, use of random number tables, two types of errors, critical and acceptance regions. Large sample test for proportion, equality of proportions, t-test for single mean and equality of means, chi-square test for independence of attributes, ANOVA ( for one-way classified data)

#### **Unit IV**

**5 hours**

Designing and Methodology of an experiment: Introduction, guidelines on methodology, observational and experimental investigation, methodology and designing, hypothesis.

MS Excel: Computation of measures of central tendencies, measures of dispersions, normal distribution, one way analysis of variance (ANOVA)

**AC 02: Instrumentation and Lab techniques****26 hrs****Objectives:**

- To acquire the knowledge of basic principles and applications of tools.
- To know the techniques for the measurement of physical, physiological, biochemical and biological factors.

**Course Outcomes**

**CO1:** Explain the principle, construction and application of different types of microscopes used to study the morphology of microbes.

**CO2:** Describe the working principle of different types of centrifuge and rotor designs.

**CO3:** Explain techniques used for characterization of bio molecules.

**CO4:** Discuss the application of electrophysiological methods used in diagnosis.

**Details:**

<b>Unit</b>	<b>Topic</b>	<b>Hours</b>
<b>I</b>	<b>Units of measurements</b> -conversion of units	06 hrs
	<b>Microscopic techniques:</b> Light microscopy- Phase contrast microscopy, Fluorescent microscopy, Dark field microscopy.	
	<b>Electron Microscope</b> - scanning and transmission microscopes, different fixation and staining techniques for EM.	
	Freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.	
<b>II</b>	<b>Centrifugation</b> – principles of Centrifugation, Types by application- industrial scale centrifuges, very high speed centrifuges and ultracentrifuges.	03 hrs
	Types by rotor design- fixed-angle centrifuges, swinging head (or swinging bucket) centrifuges and continuous tubular centrifuges.	
<b>III</b>	<b>Chromatography:</b> Principles and applications of Chromatography: Thin layer chromatography (TLC), Gel filtration chromatography.	06 hrs
	Ion exchange chromatography, Affinity chromatography	
	Gas chromatography (GC) and High-performance liquid chromatography [(HPLC).	

<b>IV</b>	<b>Biophysical methods:</b> Analysis of biomolecules using UV/visible spectroscopy, circular dichroism	<b>06</b> hrs
	NMR, X-ray diffraction; mass spectrometry	
<b>V</b>	<b>Electrophysiological methods:</b> Single neuron recording, patch-clamp recording, ECG, PET, MRI, fMRI, CAT	<b>05</b> hrs

**References:**

1. Dr. Ashok Jadhav, Dr. Avinash V. Mancharkar, Biophysics and instrumentation
2. Chang R. (1971), Basic principles of spectroscopy, McGraw-Hill.
3. Lehninger A. (1981), Biochemistry, Butter Worth Publication.

## II Semester

### CC 05: Basic Microbiology

45 hrs

#### *Objectives:*

- To understand the classification, structure and function of Microorganisms.
- To describe the various metabolic pathways in microorganisms.
- To learn microbial culturing and preservation techniques.
- To discuss the pathogenicity of pathogenic organism.

#### *Course Outcomes*

**CO1:** Describe the classification, structure and function of microorganisms.

**CO2:** Explain the various metabolic pathways in microorganisms.

**CO3:** Explain the methods used for microbial culturing and preservation techniques.

**CO4:** Describe the pathogenicity of pathogenic organism.

**CO5:** Explain the structure, classification and methods of cultivating viruses.

#### **Details:**

<b>UNIT 1</b>	<b>Ultrastructure of bacteria</b>	<b>Hrs 07</b>
	Bacterial Morphology: ultrastructure, Gram positive and Gram-negative forms; structure and significance of endospore and capsule, Nucleoid, NAPs	02
	Growth curve, Diauxic growth, Batch, continuous and synchronous cultures	02
	Factors affecting growth of bacteria, Growth kinetics; methods of enumeration of growth	02
	Bacterial nutrition, Reproduction in bacteria	01
<b>UNIT 2</b>	<b>Introduction to Microbial taxonomy</b>	<b>Hrs 06</b>
	Distinguishing features of prokaryotic and eukaryotic organisms, Concept of microbial species and strains	01
	Principles of bacterial taxonomy and classification: - Numerical taxonomy, Bergey's manual and its importance	02
	Salient features of Rickettsia, Chlamydia, Mycoplasma and Actinomycetes	03
<b>UNIT 3</b>	<b>Culture media and Pure Culture techniques</b>	<b>Hrs 06</b>
	Culture media: components of media, natural and synthetic media, chemically defined media, complex media	02
	Selective, differential, indicator, enriched and enrichment media.	02
	Definitions and Principles: Culture, Axenic culture, strains, Pure culture techniques; pour plate, streak plate and spread plate method, Enrichment culture technique	02
<b>UNIT 4</b>	<b>Preservation and Maintenance of Microbial cultures</b>	<b>Hrs 04</b>

	Repeated sub culturing, sterile soil preservation, mineral oil preservation	01
	Preservation at low temperature Deep freezing and liquid nitrogen preservation, freeze-drying (lyophilization).	02
	Advantages and disadvantages of each method.	01
<b>UNIT 5</b>	<b>General characteristics and classification of Fungi</b>	<b>Hrs 04</b>
	Fungi: General characters and classification	02
	Keratinophilic fungi	01
	Coprophilic fungi- Mechanism of spore discharge in <i>Pilobolus</i>	01
<b>UNIT 6</b>	<b>Pathogenic microorganisms</b>	<b>Hrs 06</b>
	Bacteria- <i>Vibrio cholera</i> , <i>Mycobacterium tuberculosis</i>	02
	Virus-HIV, H1N1, Dengue	02
	Protozoa-Plasmodium, <i>Entamoeba histolytica</i> , <i>Giardia lamblia</i>	02
<b>UNIT 7</b>	<b>Ultrastructure, classification and biology of Viruses</b>	<b>Hrs 06</b>
	Structure and classification of viruses	02
	Distinguishing features and importance of DNA and RNA viruses	02
	Methods of detection and cultivation- use of chick embryo, animal inoculation, tissue culture	02
<b>UNIT 8</b>	<b>Microbial metabolism</b>	<b>Hrs 06</b>
	Glycolytic pathways in microbes- EMP, HMP and ED pathways,	02
	Kreb's cycle and ETC	02
	Microbial photosynthesis and dark reactions-anaerobic	02

#### References:

1. Essentials of Microbiology. McCormick T, Research & Edn association, Piscataway, NJ, 1998.
2. Microbiology for health careers. Lynne,I., Grover-Lakinia and Fong,E., Thomson Delmer Learning, New York, 1999.
3. General Microbiology. Schlegel, H.G., Cambridge Univ. Press, London, 1996
4. General Microbiology – Sullia S.B. and Shantharam S., Oxford XIBH. Publishing Co.Pvt. Ltd. Second Edition 2005
5. A Text book of Microbiology R.C.Dubey and D.K.Maheswari.Published by S. Chand and company Ltd Ramanagar, New Delhi – 110055 -2005 Edition.

## Basic Microbiology Practicals

<b>Unit No</b>	<b>Title of the practicals – Basic Microbiology</b>	
1	Staining protocols- Gram staining	4
2	Staining protocol-Endospore staining	4
3	Isolation of microbes from soil and water- media preparation	4
4	Standard plate count – Pour Plate Method, Spread Plate Method	4
5	Isolation of microbes from soil and water -media preparation	4
6	Pure Culture Techniques – Streak plate method	4
7	Study of growth curve of bacteria	4
8	Bacterial Motility- Hanging drop method	4
9	Biochemical tests (IMViC)	4
10	Biochemical tests – Catalase,oxidase tests, starch and gelatin hydrolysis	4
11	Prefinal examination	

**CC 06: Human Physiology****45 hrs****Objectives:**

The students learn fundamentals of anatomical structures and physiology of body organs. Students get to know about skin, blood, cardiovascular system, respiration, the gastrointestinal tract, renal physiology, central and peripheral nervous system and special senses.

**Course Outcomes**

- CO 1:** Discuss in depth the physiology of the cardiovascular, nervous, respiratory, digestive, Muscular and Sensory perception from a regional perspective and the disorders associated to the organ systems.
- CO 2:** Describe briefly the basic components and functions of the digestive, excretory, muscular systems and sense organs
- CO 3:** Recognize the major organ and vessels of the cardiovascular system and understand their functioning
- CO 4:** Demonstrate competency in identifying the major structures and functions of the central and peripheral nervous system
- CO 5:** Discuss the various disease conditions associated functions, with the various organ system.

**Details:**

<b>UNIT 1</b>	<b>Sensory perception</b>	<b>Hrs 05</b>
	Structure of eye, responses of pupil to light; accommodation and color vision; Common defects of vision; color blindness, glaucoma, and cataract	2
	Physiology of olfaction and taste	1
	Structure of ear and mechanism of hearing	1
	Functions of skin and wound healing;	1
<b>UNIT 2</b>	<b>Digestive system</b>	<b>Hrs 06</b>
	Introduction to structure of GI tract (also the accessory glands), Physiology and regulation of digestion and absorption of carbohydrates, proteins and lipids.	4
	Gastritis, Peptic and duodenal ulcer, Hepatitis, Cirrhosis	2
<b>UNIT 3</b>	<b>Respiratory system</b>	<b>Hrs 05</b>
	Introduction to respiratory system, External, and internal respiration; transport of oxygen and carbon dioxide	2
	Role of hemoglobin in gas transport – chloride and reverse chloride shift	1
	Carbon monoxide poisoning, emphysema, chronic bronchitis and tuberculosis	2
<b>UNIT 4</b>	<b>Circulatory system</b>	<b>Hrs 07</b>
	Introduction to structure of heart, Coronary, systemic and pulmonary circulation, Regulation and conduction of heart beat; cardiac cycle; Blood pressure	3
	Composition and role of blood; Haemopoiesis; Mechanism of clotting	2
	ECG – interpretation of waves, angioplasty and bypass surgery	1
	Arrhythmia, murmurs, congestive cardiac failure, angina, coronary thrombosis, anemia and hemophilia	1
<b>UNIT 5</b>	<b>Nervous System – I</b>	<b>Hrs 07</b>

	Introduction to nervous system, nerve cell, action potential, propagation of nerve impulse Process of signal transmission at synapse – Chemical and electrical synapse Neurotransmitters and its role	4
	Central nervous system – Cerebrum, cerebellum, brain stem – structure and functions, cerebrospinal fluid and its role,	3
<b>UNIT 6</b>	<b>Nervous system – II</b>	<b>Hrs 05</b>
	Peripheral nervous system – structure and its functions, Reflex arc	2
	Multiple sclerosis, epilepsy, cerebral palsy, transient ischemia, Alzheimer's and Parkinson's diseases	3
<b>UNIT 7</b>	<b>Muscular system</b>	<b>Hrs 05</b>
	Ultra structure of muscle, Sliding filament mechanism, role of contractile, regulatory and structural proteins.	3
	Neuro - muscular junctions and role of acetyl choline esterase	1
	Muscle fatigue, muscle degeneration and muscle twitch; myogram	1
<b>UNIT 8</b>	<b>Excretory system</b>	<b>Hrs 05</b>
	Introduction to renal system, Renal physiology-glomerular filtration, selective reabsorption and secretion Composition of urine	3
	Nephritis, renal failure, stones, dialysis, kidney transplantation	2

**References:**

1. Ross and Wilson Anatomy and Physiology in Health and Illness – Anne Waugh and Allison Grant.
2. Anatomy and Physiology – G J Tortora.
3. Human Physiology, An Integrated Approach – Dee Unglaub Siverthorn.



### HUMAN PHYSIOLOGY PRACTICALS

Sl No	Title of the Practicals	Hrs
1.	Estimation of oxygen consumption in ornamental fish by Winkler's method	4
2.	Effect of pH on oxygen consumption of fresh water crabs by Winkler's method	
3.	Osmoregulation in fresh water crabs (Salt loss/salt gain)	4
4.	Determination of RQ in fishes – Q10 calculation	4
5.	Extraction and analysis of total proteins from animal tissues – Lowry's method	4
6.	Extraction and analysis of total carbohydrates from animal tissues - Anthrone method	4
7.	Analysis of ECG report under different situations	4
8.	Analysis of Urine report – basic profile, glucose, protein	4
9.	Analysis of Blood report - basic profile, TSH, T3 and T4; Blood glucose level.	4
10.	Prefinals	4

**CC 07: Plant Physiology****45 hrs****Objectives:**

- Enable students to understand the significance of various physiological processes in plants. To understand the metabolic reactions involved in photosynthesis, respiration and nitrogen metabolism. To appreciate the mechanisms involved in plant responses to various types of stresses and chemical defenses in plants.

**Course Outcomes**

**CO1:** Gain knowledge regarding various physiological processes taking place in plants.

**CO2:** Understand concepts related to water and mineral absorption in plants.

**CO3:** Comprehend the metabolic pathways involved in physiological processes like photosynthesis, respiration and nitrogen fixation.

**CO4:** Learn about the role of plant hormones and their role in promoting growth.

**CO5:** Discuss the types of stresses that plants are subjected to and the mechanisms they use to overcome them.

**CO6:** Understand the various chemical defenses (alkaloids, glycosides, terpenes and phenolics) used by plants.

**Details:**

<b>UNIT 1</b>	<b>Water and mineral relations and Transpiration</b>	<b>Hrs 06</b>
	Uptake, transport and translocation of water, ions, solutes and macromolecules from soil	1
	Theories in relation to absorption of water and mineral salts	3
	Transpiration	1
	Theories in relation to translocation of solutes	1
<b>UNIT 2</b>	<b>Photosynthesis</b>	<b>Hrs 07</b>
	Light harvesting complexes; Red drop effect; Emerson's enhancement, Electron flow through cyclic and non-cyclic photo-phosphorylation	4
	C3 and C4 cycles, difference between C3 and C4 cycles; CAM pathway and its adaptive advantages	3
<b>UNIT 3</b>	<b>Respiration</b>	<b>Hrs 07</b>
	Types of respiration-aerobic and anaerobic respiration	1
	Glycolysis, citric acid cycle; ATP synthesis through oxidative electron transfer chain (cytochrome system); Chemi - osmotic regeneration of ATP	3
	Pentose phosphate pathway /EMP shunt; photorespiration	3
<b>UNIT 4</b>	<b>Nitrogen metabolism</b>	<b>Hrs 07</b>
	Nitrogen fixation-symbiotic and non-symbiotic; biochemistry of nitrogen fixation;	3

	Assimilation of nitrates; Denitrification and nitrogen cycle	4
<b>UNIT 5</b>	<b>Growth promoting hormones and photobiology</b>	<b>Hrs 08</b>
	Plant hormones –auxins, cytokinins, ABA and gibberellins as regulators of plant growth- Their occurrence chemistry and mode of action	4
	Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.	4
<b>UNIT 6</b>	<b>Stress physiology of plants</b>	<b>Hrs 05</b>
	Responses of plants to biotic (pathogens and insects) and abiotic (water, temperature and salt) stresses.	5
<b>UNIT 7</b>	<b>Plant survival strategies</b>	<b>Hrs 05</b>
	Chemical defense-secondary metabolite production-alkaloids, glycosides, terpenes and phenolics	5

**References:**

1. Taiz, L. and Zeiger, E. 1998. **Plant Physiology**. 3<sup>rd</sup> Edition. Anima Publishing Corporation, New Delhi Bangalore.
2. Wilkins, M.B.(Eds.) 1989. **Advanced Plant Physiology**. Pitman Publishing LTD. London.
3. Hopkins, W.G. 1995. **Introduction to Plant Physiology**. John Wiley and sons. Inc., New York, USA
4. Moore, T.C. 1989. **Biochemistry and Physiology of Plant Hormones**. 2<sup>nd</sup> Edition. Springer-Verlag, New York, USA

## PLANT PHYSIOLOGY PRACTICALS

Sl No	Title of the practicals	Hrs
1	Measurement of water potential of potato tuber by gravimetry	4
2	Measurement of RQ using respirometer Stomatal index and structure in monocot and dicot	4
3	Study of mineral deficiency symptoms in plants – 4 deficiencies	4
4	Separation and colorimetric estimation of photosynthetic pigments- Chlorophyll A and B	4
5	Separation of plant pigments through chromatography – Paper and TLC	4
6	Estimation of leghemoglobin	4
7	Bio-assay of growth hormones - breaking of seed dormancy by gibberellins	4
8	Estimation of phenols in healthy and infected leaves	4
9	Extraction and estimation of enzymes from plant material – catalase and amylase	4
10	Prefinals	4

**CC 08: Immunology****52 hrs****Objectives:**

- To elucidate the basic concepts of immune system and its functioning.
- To outline, compare the immune mechanisms and the cells associated with innate and acquired immunity and their relation.
- To understand the basics of allergy, autoimmunity, tumors, immunodeficiencies and immunotherapy

**Course Outcomes**

**CO1:** Understand the components of immune system and elucidate the biochemical basis of immunological responses and genetic basis of diversity.

**CO2:** Discuss the mechanisms of protection against various diseases and principles governing vaccination

**CO3:** Demonstrate the basic knowledge of allergic responses; types of allergies

**CO4:** Discuss the antigen and antibody interactions

**CO5:** Demonstrate an understanding on the disorders and deficiencies associated with immune system functioning and immunotherapy

**Details:**

<b>UNIT 1</b>	<b>Introduction and Components of the immune system</b>	<b>Hrs 08</b>
	Introduction to immunity and types; Innate and Acquired immunity	01
	Non-specific barriers to infective organisms-external (physical and chemical) Skin, body secretions, mucosa  Internal defense mechanisms-WBC, macrophages, inflammatory response, fever, interferons and complement binding	03
	Lymphoid organs, Cells involved in immunity – their origin and role in defense against disease	02
	Cell mediated and Humoral immunity- role of cyto-toxic cells, macrophages, T and B lymphocytes and memory cells; Primary and secondary immune response, Clonal selection theory; Immunological memory	02
<b>UNIT 2</b>	<b>Biochemical basis of immunity</b>	<b>Hrs 08</b>

	Nature of antigens; Haptens, Adjuvants, Examples of some common antigens	02
	Structure, Types and functions of antibodies- Ig G, A, M, D and E types	02
	Antibody diversity, isotypes, allotypes and idiotypes	02
	Cytokines	02
<b>UNIT 3</b>	<b>Complement system</b>	<b>Hrs 04</b>
	Classical and alternate pathways and functions	02
	Major Histocompatibility complex and HLA Typing	02
<b>UNIT 4</b>	<b>Vaccines: Development and production</b>	<b>Hrs 04</b>
	Attenuated /inactivated organisms, toxoids, conjugate edible vaccines, DNA vaccines	02
	Protein expression systems, Production of Rabies vaccine and Hepatitis B vaccine, Therapeutic vaccines.	02
<b>UNIT 5</b>	<b>Hypersensitivity and allergic response</b>	<b>Hrs 04</b>
	Immediate hypersensitivity	<b>02</b>
	Delayed type of hypersensitivity	02
<b>UNIT 6</b>	<b>Immune response and its detection</b>	<b>Hrs 08</b>
	Introduction to Antigen - Antibody reactions	01
	ELISA, Immunofluorescence, agglutination, precipitation	03
	Immunodiffusion, immunoelectrophoresis	02
	Reactions of immune system- anti toxins, complement fixation reaction, opsonins and opsonocytaphagic reactions	02
<b>UNIT 7</b>	<b>Disorders of the immune system</b>	<b>Hrs 08</b>
	Immunodeficiency diseases: primary and secondary	02
	Transplantation immunology and immunosuppression	02
	Tumor immunology and immunotherapy for cancer	02
	Immunological tolerance and autoimmune disorders	02

UNIT 8	Hybridoma Technology and monoclonal antibody production	Hrs 08
	Myeloma cell lines, fusion of myeloma cells with antibody producing B-cells, fusion methods	02
	Screening and selection methods for positive hybrids, cloning methods.	01
	Production ( <i>in vivo</i> and <i>in vitro</i> ), purification and characterization of monoclonal antibodies,	02
	Chimeric and humanized antibodies	01
	Applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment.	02

### References:

1. Abbas Abdul K., Lightman Andrew K. and Pober Jordan S., *Cellular and Molecular Immunology*, W.B. Saunders Company, Philadelphia
2. Ananthanarayana and Paniker, *Text Book of Microbiology*, Orient and Longman, New Delhi.
3. Goldsby Richard A., Kindt, Thomas J. and Osborne Barbara A., Kuby *Immunology*, W. H. Freeman and Company, New York.
4. Jawetz, Mehick, Adelberg, Brooks, Buel and Orston, *Medical Microbiology*, Prentice Hill Incorporated, London.
5. Roitt I. M., *Essentials of Immunology*, ELBS, Blackwell Scientific Publishers, London.

## Immunology (Tutorials)

Unit No.	Title	Hours
1.	Determination of blood groups; separation of serum from blood	2
2.	Immunoglobulin separation and purification	2
3.	Precipitation and colorimetric quantification of immunoglobulins	2
4.	Immunological tests for WIDAL	2
5.	Immunological tests for VDRL	2
6.	Radioimmunoassay (RIA)	2
7.	Ouchterlony double diffusion test (ODD)	2
8.	Dot ELISA	2
9.	Immuno-electrophoresis	2
10.	Rocket immuno-electrophoresis	2
11.	Production of polyclonal antibodies from rabbits - Demonstration through visit to a suitable lab	2



**Objectives:**

To enable the students to

- Understand the methodology of research/ principles and techniques.
- Develop skill in conducting research from planning to report writing.

**Course Outcomes:**

**CO1:** Enable students to identify the overall process of designing a research study from its inception to its report.

**CO2:** Students can select and define appropriate research problem, organize and conduct research in a structured manner.

**CO3:** Also enables students to prepare a project proposal, to write a research report, articles and thesis in a decipherable manner.

**Unit I****4 hrs****Introduction to Research**

Meaning, definition, objectives and characteristics of research. Types of research- basic research (fundamental research), applied research, action research, descriptive research, analytical research, evaluation research, historical research, exploratory research, industrial research, development research.

**Unit II****Research Process****6 hrs**

Research design, important experimental designs, sample design. Census and sample method; theoretical basis for sampling, methods of sampling, size of sample, merits and limitations of sampling, sampling and non-sampling errors, reliability of sampling.

Data and methods of data collection; types of data- primary and secondary data. Primary data collection methods- direct personal investigation, direct oral investigation schedules and questionnaires, interviews and type of interviews. Pre-testing and pilot study.

**Unit III****Measurement and scaling technique****4 hrs**

Measurement in research; measurement scales- nominal scale, ordinal scale, interval scale, and ratio scale. Sources of error in measurement.

Scaling- meaning, classification basis, important scaling techniques- rating scale, ranking scale, arbitrary scale, summated scale.

#### **Unit IV**

##### **Intellectual Property Rights**

**2 hrs**

Patenting - definition of patent. Patenting and fundamental research. Product and process patents, Patent infringement, Copyright infringement and Trademarks.

#### **UNIT-V:**

##### **Scientific writing**

**6 hrs**

Research resources: reviews, abstracts, books, journal and magazine articles- Exploration and communication; Resources: online and print; Review of latest literature (peer reviewed). Logical format for writing thesis and papers. Essential features of abstract, introduction, review of literature, materials and methods, and discussion. Reference styles. Understanding Plagiarism: definition, unintentional plagiarism and consequences; Collaborative work.

##### **Unit IV: Data analysis using Excel:**

**4 hrs**

Analysis of quantitative data and effective presentation with tables, graphs etc., Use of Excel for Formulae Function, Charts and Graphs, Table formula, t-test, Anova and Correlation.

#### **Reference:**

1. Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press.
2. Experimental Design for Biologists. David J. Glass. Cold Spring Harbor Laboratory.
3. Experimental Design for the Life Sciences. Ruxton & Colegrave. Oxford University Press.
4. Research Methodology, Kothari, C. R. (2005) New Delhi, Vikas Publication House.
5. Successful Scientific writing: A step-by- step Guide for Biomedical Scientists. 2nd ed. Matthews. Cambridge University Press, 2001.
6. Green. R. H. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley & Sons, 1979.
7. Swain AKPC (2008), A Textbook Of Research Methodology, 1st Edition, Ludhiana, Kalyani Publishers
8. Sunder rao and Richardb (2006), an introduction to bio statistics, a manual for students in health sciences, 4<sup>th</sup> edition, New Delhi, Prentice Hall
9. Gupta S.P.,Statistical methods, 28<sup>th</sup> ed. Sultan chand and Co, New Delhi,1998.
10. Sinha, S.Cand Dhiman,A.K.(2002) Research methodology, Ess Publication 2 Volumes.

**AC 04: Environmental Science****26 hrs****Objectives:**

- To get awareness on the various sources, control measures and hazards related to air, land and water pollution.
- To discuss the environmental problems and management strategies used for environmental pollution.
- To understand the significances of biodiversity, genetic diversity, species diversity and ecosystem diversity.
- To get knowledge about various pollution protection Acts.

**Course Outcomes**

**CO1:** Understand the various sources, control measures and hazards related to air, land and water pollution.

**CO2:** Describe the working principle, construction and application of various dust collectors.

**CO3:** Explain the methods used for waste water treatment.

**CO4:** Discuss the process of municipal solid waste management.

**CO5:** Understand the effect of environmental toxicology.

**CO6:** Explain the role of microbes in biodegradation and bioleaching.

**Details:**

<b>Unit</b>	<b>Titles</b>	<b>Hours</b>
<b>1</b>	<b>Environmental pollution I- Air Pollution</b>	<b>05</b>
	Sources, impacts and control measures	01
	Equipments for dust and gaseous control – Settling chamber, cyclones- Mono cyclones and multi cyclones, fabric filters- cleaning the fabric filters, electrostatic precipitators, wet scrubber  (Working principle, advantages and disadvantages).	03
	Green belts as pollution sink in industrial areas.	
	Air (Prevention and Control of Pollution) Act, 1981	01
<b>2</b>	<b>Environmental pollution II - Water Pollution</b>	<b>05</b>

	Sources, types, impacts and control measures.	01
	Waste water treatment methods – - physical, biological methods (activate sludge process and trickling filters) and chemical	02
	Phytoremediation and root zone treatment system.	01
	Water (Prevention and Control of Pollution) Act, 1974	01
<b>3</b>	<b>Environmental pollution III- Land Pollution</b>	<b>05</b>
	Sources, types and control measures.	01
	Biomedical waste and radioactive wastes –handling and disposal	01
	Municipal solid waste management- Methods of disposal- Composting, vermicomposting, incineration and landfill (process, advantages and disadvantages).	02
	Municipal Solid waste Act, 2000.	01
<b>4</b>	<b>Environmental pollution - IV - Noise Pollution</b>	<b>05</b>
	Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI)	01
	Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods.	02
	Vibrations and their measurements. Impact of noise and vibrations on human health.	02
<b>5</b>	<b>Environmental Toxicology</b>	<b>06</b>
	Definition, Dose Response relationship, Types of toxic substances - drugs, food additives, industrial chemicals,	02
	Toxicity testing; Bioassay – Definition, purpose, Acute Toxicity (single); Sub acute Toxicity; Chronic Toxicity; Teratogenicity, carcinogenicity and mutagenicity.	02
	Heavy metals toxicology -lead and mercury	02

### References:

1. Environmental biology. Jones, A.M. Routledge, London, 1997
2. Environmental soil biology. Wood, M., Springer, New York, 1995

3. Conservation Biology in theory and Practice. Caughley, G and Gunn,A., Blackwell Publications, London, 1995
4. Chemistry of Environmental Science. Sawyer, SC.N., McCarty, P.L and parking, G.F., McGraw Hill Professional, New York, 2002.
5. Paper, W. Environmental Microbiology 5<sup>th</sup> Edition, McGraw Hill 1993
6. Eisehart, G.D. and Baumgardener 1981 Population Biology Aan Nos Stran Co., NY
7. Singh, H.R. Animal Ecology and Environmental Biology 1989
8. Khatolisya, Environmental Pollution – Management and Control for Sustainable development. S. Chand Co., New Delhi 2004.
9. Nalini, K.S Environmental resources and management, Anmol publishers. 1993.
10. Boyle, Renewable energy resources 1994.
11. Air pollution: Rao and Rao, 1999, Tata McGraw-Hill Publishing Company Limited.
12. Principle of Toxicology: Environmental and Industrial Applications: Williams, Robert C. James, and Stephen M. Roberts, 2000, Wiley and Sons.
13. Chemistry for Environmental Engineering: Sawyer, C.N and Mc Carty, P.L. 1978. McGraw Hill Book co.
14. Chemical and Biological methods of Water pollution Studies: Trivedi, P.K. and Goel, p.K. 1984. Environmental Publication
15. Wastewater Microbiology: Bitton, G. 1994. Wiley - Liss Inc.

### Semester III

#### EC 01: Applied Microbiology

45 hrs

#### Objectives:

#### Course Outcomes

**CO1:** Introduce the components of industrial media and design of fermentors.

**CO2:** Understand the methods of screening industrially important organisms and production of fermentation products

**CO3:** Demonstrate the microbiology of dairy products and understand their therapeutic value

**CO4:** Elucidate the factors influencing the growth of microbes in food , study food borne diseases and understand the various microbial examination and food preservation techniques

**CO5:** Demonstrate the knowledge on air microbiology, various air sampling techniques and understand biohazards in occupational environments.

**CO6:** Understand rhizospheric and phyllopheric microbes; their beneficial role on plants; their use as biofertilizers and biopesticides and role of soil microbes in leaching of metals

#### Details:

<b>UNIT 1</b>	<b>Introduction to industrial microbiology</b>	<b>Hrs 07</b>
	Media components; sterilization of media, Inoculum preparation,	02
	Basic structure of a fermentor; construction and process parameters of a stirred aerated fermenter	02
	Types of industrial processes – batch, fed - batch and continuous	01
	Surface, submerged processes and SSF	02
<b>UNIT 2</b>	<b>Microbial technology</b>	<b>Hrs 08</b>
	Industrial production of alcohol, organic acid-(citric acid) ,	02
	Industrial production of antibiotics(penicillin) enzymes(amylase)	02
	Downstream processing	02
	Immobilization of enzymes and cells	02
<b>UNIT 3</b>	<b>Dairy microbiology</b>	<b>Hrs 08</b>
	Micro-organisms in milk-milk as a substrate	01
	Sources of microbial contamination of milk, Biochemical changes in milk	01
	Analysis of milk –physical, chemical, microbial and molecular	03
	Fermented milk products- Yoghurt and Cheese Production	03
<b>Unit 4</b>	<b>Food microbiology</b>	<b>Hrs 06</b>
	Food as a substrate for micro-organisms	01

	Principles of food spoilage;	01
	Microbial examination of food	01
	Preservation of food	01
	Food borne infections	02
<b>UNIT 5</b>	<b>Air microbiology</b>	<b>Hrs 05</b>
	Significance of air borne microbes –their control and management	01
	Techniques of tapping air borne microbes-solid impaction: Plating technique,, Rotorod, Cascade and Anderson samplers	02
	Liquid impingement filtrations-	02
	Biohazards in occupational environment; allergens	01
<b>UNIT 6</b>	<b>Agricultural microbiology</b>	<b>Hrs 08</b>
	Soil microorganisms- in rhizosphere, rhizoplane and phylloplane and their role	02
	Mycorrhiza and its importance	02
	Bioleaching of metals-copper and zinc	02
	Biodegradation of cellulose, hemicelluloses, pectin and lignin	01
	Biodegradation of plastics and pesticides	01

#### References:

1. Food Microbiology: Arnold-Beety C. Hobbs, Heinemann Publishing Private Limited, New Delhi.
2. Food Microbiology: Frazier and Washhoff, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995
3. Dairy Bacteriology: Hammer B. W. and Babal, Prentice Hall Incorporated, London 1957
4. Modern Food Microbiology: Jay J. M., CBS Publishers and Distributors, New York, 1992.
5. Industrial Microbiology: Casida L. E., Wiley Easter Limited, New Delhi, 1968
6. Principles of Fermentation Technology: Stanburry, P. F., Whitaker A. and Hall S. J., Elsevier Science Limited, Aditya Books Private Limited, New Delhi, 1994

## APPLIED MICROBIOLOGY PRACTICALS

Sl No	Title of the practicals – Applied Microbiology	Hrs
1	Water Analysis-MPN and membrane filtration	4
2	Collection , isolation and identification of air borne microbes —from at least four different environments	4
3	Isolation and study of <i>Rhizobium</i>	
4	Isolation and study of <i>Azotobacter</i>	4
5	Production of wine from different varieties of grapes and analysis of sugar(biochemical method) and alcohol content(specific gravity method)	4
6	Production of wine from different varieties of grapes and analysis of sugar(biochemical method) and alcohol content(specific gravity method)	4
7	Production and estimation of citric acid from fungi	4
8	Isolation and identification of microbes from different food samples –fermented food and spoiled food	4
9	Bacterial examination of milk by SPC,	4
10	DMC and MBRT of milk	4
11	Estimation of lactose and lactic acid content of milk from different sources	4
12	PREFINALS	4



**EC 02: Molecular Biology****45 hrs****Objectives:**

To enable student to appreciate the scope and importance of molecular biology. To understand the importance of DNA as the genetic material. To get a grasp of fundamental processes that take place in the cell including DNA replication and protein synthesis as well as regulation of gene expression. To understand the significance of mutations and DNA repair mechanisms.

**Course Outcomes**

**CO1:** Understand various concepts related to molecular biology including DNA and RNA structure, DNA replication, transcription and translation.

**CO2:** Learn the structure and functions of nucleic acids.

**CO3:** Understand the mechanism of DNA replication and recombination.

**CO4:** Gain knowledge regarding types of mutations, mutagens and DNA repair mechanisms.

**CO5:** Study the mechanism involved in transcription including mRNA synthesis and processing.

**CO6:** Study the mechanism involved in translation (initiation, elongation and termination), including ribosome structure and its role in peptide synthesis. Understand the characteristics and features of the genetic code.

**CO7:** Discuss the mechanisms that regulate gene expression both in prokaryotes and eukaryotes.

**Details:**

<b>UNIT 1</b>	<b>Experimental proofs and structure of nucleic acids</b> (A-, B-, Z-, DNA, t-RNA, micro-RNA).	<b>Hrs 06</b>
<b>UNIT 2</b>	<b>DNA replication, repair and recombination</b>	<b>Hrs 07</b>
	Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication,	4
	Extra-chromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.	3
<b>UNIT 3</b>	<b>Mutation and DNA repair mechanisms</b>	<b>Hrs 05</b>
	Types of mutations; stages at which mutations occur; detection of sex-linked mutations (CIB method); mutagenic agents – physical and chemical mutagens.	3
	Mismatch repair, AP repair, photoreactivation, excision repair, SOS repair system.	2
<b>UNIT 4</b>	<b>RNA synthesis and processing</b>	<b>Hrs 09</b>

	Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination.	5
	RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.	4
<b>UNIT 5</b>	<b>Protein synthesis and processing</b>	<b>Hrs 09</b>
	Genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, ribosomes, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination.	5
	Translational proof-reading, translational inhibitors, Post- translational modification of proteins.	4
<b>UNIT 6</b>	<b>Control of gene expression at transcription and translation level</b>	<b>Hrs 09</b>
	Prokaryotic and Eukaryotic genes, Introduction, Inducible and repressible systems, House-keeping genes, Levels of control of gene activity	3
	Transcriptional control in Prokaryotes: The Operons - Lactose operon (Allosteric control), Arabinose operon - Positive and negative control, Galactose operon - Alternate start points.	3
	Regulation beyond transcription initiation, premature termination of transcription - Tryptophan operon (trp attenuator) and Histidine operon (His attenuator).	3

**References:**

1. Molecular biology of cell. Albert, B., Johnson,A., Raff, M., Roberts, K., Walter,P. Garland Sciences, New York, 2004.
2. Molecular cell biology. Lodin,H., Berk,A., Zipursky,S.L., Matsudain,P., Baltimore,D and Darneil T. Will Freeman company, New York, 2001
3. Genes VI. Lewin, B.C, Oxford University press, New York 1994
4. The Cell – A molecular approach. Cooper, G.M. Princeton Publishers, New York, 2000

## MOLECULAR BIOLOGY - Practicals

Unit No	Title	Hrs
1.	Cell separation and differential centrifugation	4
2.	Genomic DNA extraction from plant and animal sources	4
3.	Protein extraction from plant source and purification	4
4.	Analysis of protein by SDS-PAGE	4
5.	Plasmid Isolation	4
6.	Restriction digestion of DNA	4
7.	Ligation of DNA fragments	4
8.	Agarose electrophoresis of digested and ligated DNA samples	4
9.	Prefinals	4

**EC 03: Human Endocrinology and Reproductive Biology****45 hrs****Objectives:**

The major objective of this course is to provide students with a sound coverage of human endocrinology and reproductive biology. This is achieved by covering basic endocrinology and its regulation, fundamentals of the structure and function of the male and female reproductive tracts, gametogenesis, fertilization, early embryogenesis, fetal development and preparation for birth, and maternal adaptations to pregnancy and how reproductive biotechnology is used to overcome poor fertility.

**Course Outcomes**

**CO 1:** Demonstrate an understanding of the endocrine organ system. The role of the hormones in maintaining body function. The student will demonstrate knowledge of the major endocrine disorders

**CO 2:** Demonstrate an understanding of the basic properties of hormones. Describe major actions of each hormone on target cells

**CO 3:** Students will have broad understanding of reproductive system

**CO 4:** Students will gain a good basic knowledge of the biological events of early human developmental biology

**CO 5:** Students will have basic knowledge of reproductive anomalies and assisted reproductive technology

**Details:**

<b>UNIT 1</b>	<b>An introduction to Endocrinology</b>	<b>Hrs 06</b>
	Human endocrine organs , their functions, hypo and hyper secretions and effects--Pituitary, thyroid, parathyroid, adrenal, pancreas, gonads, pineal gland	04
	Hypothalamo- hypophyseal axis; stimulatory and inhibitory factors; feedback control.	02
<b>UNIT 2</b>	<b>Hormone action</b>	<b>Hrs 06</b>
	Mechanism of Hormone action; cAMP as second messenger	02
	Steroid biogenesis	02
	Classification, structure , biosynthesis and biological role of prostaglandins	02
<b>UNIT 3</b>	<b>Reproductive system</b>	<b>Hrs 05</b>
	Male reproductive system-Structure and functions of testis , epididymis, vas deferens and the accessory glands	02
	Female reproductive system-ovaries, oviducts, uterus and vagina	02
	Menstrual cycle and its regulation	01
<b>UNIT 4</b>	<b>Gonad differentiation , gametogenesis and fertilization</b>	<b>Hrs 06</b>
	Differentiation and development of fetal gonads and accessory duct system	02
	Sex determination and sex differentiation	02
	Gametogenesis; gametes and their structure	01

	Fertilisation	01
<b>UNIT 5</b>	<b>Cleavage and pre- implantation development in vertebrates</b>	<b>Hrs 06</b>
	Cleavage- types of cleavage establishment of polarity	02
	Gastrulation and morphogenetic movements	01
	Induction and morphogenesis	01
	Implantation and decidual reaction	02
<b>UNIT 6</b>	<b>Placentation, Development and parturition of human fetus</b>	<b>Hrs 05</b>
	Development of placenta and extra embryonic membranes through pregnancy	02
	Placenta as an endocrine organ	01
	Morphological growth indices of the fetus through pregnancy	01
	Parturition- its initiation and progress	01
<b>UNIT 7</b>	<b>Developmental anomalies and prenatal diagnostics</b>	<b>Hrs 05</b>
	Developmental anomalies	01
	Chromosome anomalies, chorionic villus sampling and amniocentesis for congenital anomalies	01
	Neonatal distress- fetal distress and its repercussion post delivery, Preterm delivery, respiratory distress, neonatal jaundice, lactose intolerance	03
<b>UNIT 8</b>	<b>Reproductive anomalies</b>	<b>Hrs 06</b>
	Reproductive dysfunctions in male- Azoospermia, prostate enlargement, cryptorchidism	02
	Reproductive dysfunctions in female-menstrual disorders(amenorrhea, premenstrual syndrome, dysmenorrhea); polycystic ovaries	01
	Fertility control measures	01
	Causes and Treatment of male and female infertility	01
	Assisted Reproduction technology	01

### References:

1. Human Reproductive Biology - Richard E Jones.
2. Reproductive Biology – Gayathri Prakash
3. Endocrinology and Reproductive Biology - K V Sastry

### Human Endocrinology and Reproductive Biology - Practicals

Unit No	Title	Hrs
1.	Endocrine glands – histology of pancreas, ovary and testis	4
2.	Endocrine glands – histology of adrenal gland, pituitary and thyroid	4
3.	Types of egg – insect, frog, avian and mammalian egg	4
4.	Cleavage, gastrulation and neurulation in frog	4
5.	Window pane technique – Chick egg	4
6.	Developmental stages in Chick – 18, 24, 32, 48 and 72 h	4
7.	Role of thyroid hormones in the metamorphosis of amphibians	4
8.	Study of human fetal development	4
9.	Histology of placenta in human	4
10.	Prefinals	4

**EC-04: Plant Developmental Biology and Plant Diseases****45 hours****Objective:**

1. To familiarize the students with various processes involved in the embryological development of plants
2. To introduce students to some aspects of plants diseases caused by bacteria and fungi

**Course Outcome:**

**CO1:** Understand the process of microsporogenesis in plants along with the study of various aspects of pollen grains.

**CO2:** Study the process of megasporogenesis and organization of the female gametophyte.

**CO3:** Appreciate the concept of double fertilization that is unique to angiosperms.

**CO4:** Study the process of embryogenesis in plants and understand the role of the endosperm.

**CO5:** Learn about some bacterial and fungal diseases of plants.

**Details**

<b>Unit 1</b>	<b>Plant Embryology – Microsporogenesis and Palynology</b>	<b>07 hrs</b>
	Microsporangium and its role in anther differentiation	2
	Microsporogenesis	1
	Pollen structure and pollen mitosis; Pollenin, sporopollenin, pollenkit and ultra-structure of microspore.	2
	Male germ unit(MGU) concept, composition and significance - pollen grain and pollen tube as components of MGU	2
<b>Unit II</b>	<b>Megasporogenesis</b>	<b>06 hrs</b>
	A general account of ontogeny and structure of ovule	1
	Megasporogenesis	2
	Ultrastructure and diversity in the organization of female gametophyte	2
	Embryo sac haustoria	1
<b>Unit III</b>	<b>Fertilization</b>	<b>06 hrs</b>
	Structure of stigma and style	2
	Pollen germination – <i>in vivo</i> --entry into stigma	2
	Pollen tube growth and entry into female gametophyte	1
	Double and Hetero fertilization	1
<b>Unit IV</b>	<b>Embryogenesis</b>	<b>06 hrs</b>
	Structure, composition and development of endosperm and embryo	2
	Embryo-endosperm relationship	2
	Apomixis and polyembryony	2

<b>Unit V</b>	<b>Plant Diseases</b>	<b>06 hrs</b>
	Introduction to plant diseases; Koch's postulates	2
	Mode of plant pathogen infection	2
	Common disease symptoms in plants	2
<b>Unit VI</b>	<b>Bacterial Diseases of crop plants</b>	<b>07 hrs</b>
	Introduction to bacterial diseases in crop plants	<b>1</b>
	Black gram or Bacterial blight of Cotton	<b>2</b>
	Citrus canker (bacterial)	<b>2</b>
	Crown gall disease	<b>2</b>
<b>Unit VII</b>	<b>Fungal Diseases of Crop Plants</b>	<b>07 hrs</b>
	Introduction to fungal diseases in crop plants	<b>1</b>
	Downy mildew in grapes	<b>2</b>
	Koleroga / Fruit Rot in arecanut	<b>2</b>
	Red rot of sugarcane	<b>2</b>

**References:**

1. Ravichandra, N. G.,: "Fundamentals of Plant Pathology". (2013)
2. Rai, M.: "Biocontrol of Plant Diseases". (2008)
3. Bhojwani S. S. and Bhatnagar S. P.: "The Embryology of Angiosperms". 1979
4. Maheshwari P. "An Introduction to the Embryology of Angiosperms" 1950



### Plant Developmental Biology and Plant Diseases - Practical

No.	Title	Hrs
1	Study of anther sections	4
2	Pollen grain study – different morphological types	4
3	Induction of and rate of pollen germination under different conditions (using boric acid)	4
4	Mellitopalynology – study of pollen grains in honey	4
5	Ovule structure and ovule types	4
6	Types of placenta	
7	Mounting of endosperm and embryo	4
8	Study of diseased plant samples – fungal (permanent slides)	4
9	Study of diseased plant samples - bacterial	4
10	Preparation of plant pathology herbarium	4
11	Pre-final Exam	4

**EC – 04 Animal Tissue Culture****Total Hours: 52****Objectives:**

- To focus on aspects of cell culture, like design and layout of the laboratory, aseptic techniques, cell culture environment (substrate, gas phase, medium) and the culturing of specific cell lines.
- To give an insight to applications of animal cell culture, bioethics and bio-safety regulations.

**Course Outcome:**

**CO1:** Knowledge on laboratory layout, basics of media preparation, sterilization and factors influencing cell culture.

**CO2:** Learn cell culture techniques their maintenance and preservation.

**CO3:** Apply cell and molecular techniques to *in vitro* conditions.

**CO4:** Understand the applications of cell culture.

**CO5:** Understand the bio - safety procedures and bioethics needed for tissue culture

<b>UNIT I</b>	<b>Animal Cell Culture - I</b>	<b>10Hours</b>
	Introduction, cell culture laboratory-design, layout and maintenance, equipment and instrumentation, methods of sterilization.	04
	Culture media, composition, preparation and metabolic functions and their types. Role of CO <sub>2</sub> , BSS, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media.	06
<b>UNIT II</b>	<b>Animal Cell Culture - II</b>	<b>08 Hours</b>
	Culture and maintenance of primary and established cell lines. Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation, Scaling up of culture.	05
	Characterization of cultured cells, viability, cytotoxicity (MTT assay), cryopreservation.	03
<b>UNIT III</b>	<b>Stem cells and Tissue Engineering</b>	<b>08 Hours</b>

	Embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences.	04
	Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.	04
<b>UNIT IV</b>	<b>Transgenic Animals and Animal cloning</b>	<b>10 Hours</b>
	Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases.	06
	Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for live stock.	04
<b>UNIT V</b>	<b>Applications of Animal Biotechnology</b>	<b>10 Hours</b>
	Improvement of biomass, disease resistant, recombinant vaccines for poultry, live stock-pharming products.	04
	Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines.	06
<b>UNIT VI</b>	<b>Bioethics and Biosafety</b>	<b>06 Hours</b>
	Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation.	03
	The Cartagena protocol on biosafety, biosafety regulations with regard to rDNA technology, transgenic science.  GMP and GLP.	03

### References:

1. Ballinic C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon press, New York. 1989.
2. Watson J.D. et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings. 2007.
3. Berger S. L. and A.R. Kimmel. Methods in enzymology guide to molecular cloning

techniques (Vol 152). Academic Press Inc. San Diego.1996

4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology. ASM Press, Washington DC.2003.

5. Jenni,P, Mather and David Barnes, Methods in Cell Biology (Vol 57) Academic Press.2001

6. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001

7. Watson J.D et al. Molecular Biology of the Gene(6th Ed), The Benjamin Cummings Pub.Co.Inc.USA.2008

8. Shantharam, D., Jane F Montgomery. Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for Sustainable development. 1999

9. Jan Freshney. R .Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Ed.) Wiley & Sons. 2010

10. John Davis., Animal Cell Culture: Essential Methods (1st Ed.) Wiley-Blackwell and Sons publisher. 2011

11. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003

## Animal Tissue Culture Tutorial

Unit No	Title	Hrs
1	Lab lay-out and Instrumentation	2
2	Biosafety levels and Disposal methods for Bio – hazardous waste	2
3	Media preparation and Sterilization	2
4	Preparation of culture bottles and their sterilization	2
5	Extrusion of earthworm coelomocytes	2
6	Establishment of coelomocyte culture- cell culture- suspension culture and adherent culture	2
7	Cell Viability tests	2

**EC – 04 Plant Tissue Culture****Total Hours 52****Objective:**

To acquaint the students with technological aspects of plant tissue culture which have direct applications in agriculture, crop improvement and industrial processes.

**Course Outcome:**

**CO1:** Learn the basic laboratory organization, culture media, various culturing methods and germplasm conservation.

**CO2:** Understand the various transformation techniques.

**CO3:** Application of DNA technology, plant cell as biofactories for the production of Secondary metabolites.

**CO4:** Understand the antisense technology and its applications.

**CO5:** Learn the concepts of bioethics, GMP and GLP.

<b>UNIT I</b>	<b>Plant Tissue Culture</b>	<b>12Hours</b>
	Importance of plant tissue culture- Media composition and types, hormones and growth regulators - auxin, gibberellins, cytokinins, abscissic acid, acetylene, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines.	06
	Micro -propagation, somatic embryogenesis, protoplast, isolation culture and somatic hybridization, germplasm collection and conservation.	06
<b>Unit II</b>	<b>Plant Transformation Techniques</b>	<b>08 Hours</b>
	Mechanism of DNA transfer – Agrobacterium mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors.	04
	Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-p Bluescript IIKs, Transgene stability and gene silencing.	04
<b>UNIT III</b>	<b>Metabolic engineering of plants</b>	<b>10 Hours</b>
	Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.	06

	Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.	04
<b>UNIT IV</b>	<b>GM Technology</b>	<b>10 Hours</b>
	Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato.	07
	Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds	03
<b>UNIT V</b>	<b>Post-harvest technology</b>	<b>06 Hours</b>
	RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons).	04
	Post-harvest protection of cereals, millets and pulses.	02
<b>UNIT VI</b>	<b>Bioethics</b>	<b>06 Hours</b>
	GM crops. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). Ethical issues associated with GM crops and GM food	

### References:

1. Chrispeels M.J.et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
2. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2<sup>nd</sup> Ed.) Narosa Publishing House. New Delhi.1998
3. Hammound J, P McGravey & Yusibov.V. Plant Biotechnology, Springer verlag.2000
4. Heldt. Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt.Ltd. Delhi. 1997
5. Lydiane Kyte and John Kleyn. Plants from test tubes. An introduction to Micropropagation (3rd Ed.). Timber Press, Portland. 1996
6. Murray D.R. Advanced methods in plant breeding and biotechnology.Panima Publishing Corporation.1996

7. Nickoloff J.A. Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana press incorp, USA. 1995.
8. Sawahel W.A. Plant genetic transformation technology. Daya Publishing House, Delhi.1997
9. Gistou, P and Klu, H. Hand book of Plant Biotechnology (Vol. I & II). John Publication.2004
10. Slatu A et al. The genetic manipulation of plant. Oxford University Press.2003
11. Kirakosyan A and Kaufman P.B. Recent Advances in Plant Biotechnology (1<sup>st</sup> Ed.). Springer Publishers.2009
12. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

### **Plant Tissue Culture Tutorial**

<b>Unit No</b>	<b>Title</b>	<b>Hrs</b>
1	Lab lay-out and Instrumentation	2
2	Media preparation I - Stock preparation	2
3	Media preparation II and Sterilization	2
4	Preparation of culture bottles and their sterilization	2
5	Callus initiation-preparation of explants-their sterilization and inoculation- leaf, nodal bud, anther culture	2
6	Sub culturing of callus, suspension culture	2
7	Synthetic seed production	2



**AC – 05 Basic Bioinformatics****26 hrs**

**Objective:** To impart students with basic knowledge in bioinformatics, use biological databases and tools in research.

**Course outcomes:** Students get information about recent advances in genomics, proteomics and structural biology and acquisition & application of biological data available from Internet-accessible databases and tools.

<b>UNIT I</b>	<b>Biological Databases</b>	<b>08 Hours</b>
	Introduction to Bioinformatics NCBI, EMBL, DDBJ, SWISSPROT, PDB, SCOP, KEGG	
<b>UNIT II</b>	<b>Computational sequence analysis</b>	<b>06 Hours</b>
	Introduction to Global alignment, Local Alignment, Pairwise Alignment, Multiple Alignment Gap, Gap penalty, BLAST, FASTA, ORF finder	
<b>UNIT III</b>	<b>Phylogenetic Analysis</b>	<b>05 Hours</b>
	Significance of Phylogenetic Studies Dendogram, Phylogenetic Tree construction – UPGMA Method	
<b>UNIT IV</b>	<b>Protein Structure Prediction</b>	<b>07 Hours</b>
	Importance of Protein Structure Prediction Secondary structure prediction tools, Chou Fasman Method Tertiary structure prediction method – Homology Modelling	

## **PET BEHAVIOUR AND CARE (Open Elective – OE -01)**

**Total hrs – 26**

### **Unit 1**

**4hrs**

#### **Introduction**

- Role of pets as companions, therapy and guard animals; common and uncommon pets.
- Impact of caging and breeding, coping with loss of pets / owners.
- Ethics in animal keeping.

### **Unit 2**

**8 hrs**

#### **Dogs as pets**

- Types of breeds, life cycle and breeding habits.
- Food preferences, diseases and prevention.
- Selection of pups, immunization and training the pup.
- Pet grooming, pet shelters and pet camps.

### **Unit 3**

**6hrs**

#### **Cats as pets**

- Types of breeds, life cycle and breeding habits.
- Food preferences, diseases and prevention.
- Selection of kittens, immunization and grooming.

### **Unit 4**

**4hrs**

#### **Fishes as pets**

- Common aquarium fishes – breeds, habitat, feed, breeding, fish diseases and treatment.
- Types of aquarium, aquarium plants and aquascaping.

### **Unit 5**

**4 hrs**

#### **Birds as pets**

- Types of breeds, life cycle and breeding habits.
- Food preferences, diseases and prevention.

## SEMESTER-IV

### EC - 05: Clinical Biochemistry and Diagnostics

45 hrs

#### Objectives:

Aims to initiate the student in understanding the in vitro study of the biological properties that contribute to the prevention, diagnosis, prognosis and monitoring of diseases and disease states in humans

#### Course Outcomes

**CO1:** Understand enzyme chemistry and its classification

**CO2:** Elucidate enzymes as a diagnostic tool

**CO3:** Understand the carbohydrate, lipid and protein metabolism and the associated abnormalities

**CO4:** Demonstrate the biological roles of metal ions

**CO5:** Describe the different organ function tests

**CO6:** Understand the clinical applications of radioisotopes

<b>UNIT 1</b>	<b>Enzymes</b>	<b>Hrs 05</b>
	Classification, enzyme units	<b>1</b>
	Factors affecting enzyme activity, enzyme inhibition, enzyme specificity, Enzyme regulation	<b>3</b>
	Co-enzymes, isoenzymes, EC number	<b>1</b>
<b>UNIT 2</b>	<b>Disorders of Glucose and Protein metabolism</b>	<b>Hrs 08</b>
	Homeostasis, diabetes mellitus- types IDDM and NIDDM	<b>3</b>
	Detection of DM – GTT/IGT	<b>1</b>
	Glucose profiles – HbA1C, lactic acidosis.	<b>2</b>
	Maple syrup urine disease. Role of folic acid in amino acid metabolism of PKU	<b>2</b>
<b>UNIT 3</b>	<b>Disorders of Lipid metabolism</b>	<b>Hrs 05</b>
	Details of plasma lipoproteins	<b>2</b>

	Disorders of lipid metabolism, hyperlipidemia, familial triglycosidemia and Tangier's disease	<b>3</b>
<b>UNIT 4</b>	<b>Electrolyte balance and disorders of porphyrin metabolism</b>	<b>Hrs 08</b>
	Biological role of electrolytes	<b>2</b>
	Biological importance of calcium, magnesium, ferrous iron and zinc	<b>2</b>
	Porphyrin metabolism and its related chromoproteins. – haemoglobin, methaemoglobin, sulphohaemoglobin, carboxyhaemoglobin, metalbumin and myoglobin	<b>4</b>
<b>UNIT 5</b>	<b>Tests for the function of kidney, liver and thyroid</b>	<b>Hrs 08</b>
	Kidney function test – urea clearance test, creatinine clearance test, nephritic syndrome, urine analysis, renal stones, biochemical findings in various renal diseases, glomerular nephritis – hematuria.	<b>3</b>
	Liver function test, hyperbilirubinemia, Gilbert's disease, Crigler-Najjar syndrome, Dubin-Johnson syndrome and rotor syndrome, liver disease, hepatitis, cirrhosis and its diagnosis.	<b>3</b>
	Thyroid function test – role of T4, T3 and TSH abnormalities in thyroid hormone function, goiter	<b>2</b>
<b>UNIT 6</b>	<b>Enzymes as diagnostic tools</b>	<b>Hrs 06</b>
	Isoenzymes and coenzymes,	<b>1</b>
	Importance of Creatinine kinase, lactate dehydrogenase, alkaline phosphatase	<b>2</b>
	Tissue damage- cardiac enzymes, liver and muscle enzymes	<b>2</b>
	Enzyme replacement therapy, Anticoagulants.	<b>1</b>
<b>UNIT 7</b>	<b>Applications of Radioactivity in Clinical practice</b>	<b>Hrs 05</b>
	Stable and radioactive isotopes; Radio-activity and half life	<b>2</b>
	Definition of specific activity;	<b>1</b>
	Radioactive-isotopes in clinical treatment and chemotherapy, Safety measures.	<b>2</b>

**References:**

1. **Textbook of Biochemistry with Clinical Correlations, Fourth Edition** by Thomas M. Devlin
2. **Clinical Biochemistry: Metabolic and Clinical Aspects** 3rd Edition by William Marshall Márta Lapsley Andrew Day Ruth Ayling
3. **Handbook of Clinical Biochemistry** 2<sup>nd</sup> Edition by R. Swaminathan

**CLINICAL BIOCHEMISTRY AND DIAGNOSTICS PRACTICALS**

<b>Unit No</b>	<b>Title of the Practical</b>	<b>Hrs</b>
1	Assay of activity of salivary amylase.	4
2	Effect of temperature on activity of salivary amylase.	4
3	Assay of activity of SGOT and SGPT (Transaminase activity).	4
4	Estimation of A/G ratio by Biuret method.	4
5	Estimation of ascorbic acid.	4
6	Estimation of hemoglobin in blood Wong's method.	4
7	Analysis of normal and abnormal constituents of urine.	4
8	Estimation of urea in urine by Nessler's method.	4
9	Estimation of creatine and creatinine in urine.	4
10	Study of blood lipid profile.	4
11	Prefinal examination	4

**EC 05: Food and Fermentation Technology****45 hrs****Objectives:****Course Outcomes**

**C01:** Demonstrate the need for Food Safety and understand the concepts of food adulteration and guidelines to used food additives

**C02:** Introduce the significance of functional foods

**C03:** Understand the various concepts of fermentation

**C04:** Demonstrate the role of microbial and biochemical factors in spoilage of foods

**C05:** Understand the beneficial roles of microbes in fermentations

**C06:** Introduce the concepts, significance and functions of food packaging and types of packaging materials

**Details:**

<b>Unit I</b>	<b>Food Safety</b>	<b>6 Hrs</b>
	Microorganisms associated with foods and the sources of microbial contamination of foods.	2
	Factors affecting food safety- Physical, biological and chemical hazards	2
	Concerns of genetically modified food, HACCP	2
<b>Unit II</b>	<b>Food Additive</b>	<b>6 Hrs</b>
	Antioxidants, Preservatives,	2
	Food colors, Flavoring agents, emulsifying and stabilizing agents,	2
	Anticaking agents, buffering agents, Sweetening agents and other additives	2
<b>Unit III</b>	<b>Food Adulteration</b>	<b>5 Hrs</b>
	Common food Adulterants	1
	Classification for adulterants, Harmful effects of adulterants,	2
	Methods for detections of some adulterants	2
<b>Unit IV</b>	<b>Functional food</b>	<b>6 Hrs</b>
	Vitamins and mineral enriched products	1

	Product containing added fiber, , omega 3 fatty acid	2
	pre, pro and synbiotics	2
	Drinks with herb blends	1
<b>Unit V</b>	<b>Fermentation processes</b>	<b>6 Hrs</b>
	Component parts of a fermentation process, Types of fermentation processes- batch and continuous	2
	Surface, submerged processes and SSF	2
	SCP: Cultivation of mushroom and spirulina	2
<b>Unit VI</b>	<b>Food spoilage</b>	<b>6 Hrs</b>
	Spoilage of fruits, vegetables	2
	Spoilage of meat and poultry products	2
	Spoilage of fermented foods	1
	Food sanitation in food manufacture	1
<b>Unit VII</b>	<b>Role of microorganisms in fermented foods</b>	<b>6 Hrs</b>
	Fermented Vegetable food- Sauerkraut, Olive Product and Cucumber, Soya Bean products.	2
	Economically important fermentation products- production of beer, wine	2
	Fermented milk products-yoghurt and cheese	1
	Fermented baked products	1
<b>Unit VIII</b>	<b>Food packaging</b>	<b>4 Hrs</b>
	Concepts, significance and function	1
	Classification of packaging methods	2
	Labelling requirement and bar coding	1

**References:**

1. Food Microbiology: Arnold-Beety C. Hobbs, Heinemann Publishing Private Limited, New Delhi.

2. Food Microbiology: Frazier and Washhoff, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995
3. Dairy Bacteriology: Hammer B. W. and Babal, Prentice Hall Incorporated, London 1957
4. Modern Food Microbiology: Jay J. M., CBS Publishers and Distributors, New York, 1992.
5. Industrial Microbiology: Casida L. E., Wiley Easter Limited, New Delhi, 1968
6. Principles of Fermentation Technology: Stanburry, P. F., Whitaker A. and Hall S. J., Elsevier Science Limited, Aditya Books Private Limited, New Delhi, 1994

### **Food and Fermentation Technology Lab**

<b>Sl No</b>	<b>Title of the Practical</b>	<b>Hrs</b>
1	Introduction to safety in the food microbiology laboratory	4
2	Microbiology of fruits and vegetables	4
3	Microbiology of canned foods	4
4	Quality evaluation of various raw materials for food processing	4
5	Isolation of microorganisms from fermented foods	4
6	Detection of food adulterants	4
7	Preservation methods	4
8	Organoleptics, nutritional and sensory evaluation of processed food	4
9	To study blanching as a means of preservation of food	4
10	To study the types of packages	4
11	Production of a fermented food	4
12	Moisture content comparison of fresh and intermediate moisture foods	4
13	Prefinals	4



**EC 06: Evolution and Ethology****52 hrs****Objectives:**

This is a course in evolutionary biology and ethology uses animal and plant examples to illustrate and clarify fundamental concepts. The course will concentrate on basic evolutionary mechanisms and theory. The course will also examine fundamental concepts in animal behavior, genetics, physiology of behavior, ecology of behavior, and the evolution of behavior.

**Course Outcomes**

**CO1:** Students will be able to describe the history and development of evolutionary thought.

**CO2:** Students will be able to list and describe the evidence for evolution and its required corollaries. Appreciate evolutionary time scale and origin of unicellular to humans.

**CO3:** Describe the molecular mechanisms by which evolution occurs. Provide detailed explanations of the processes of evolution by mutation, migration, genetic drift, non-random mating, and natural selection.

**CO4:** Understand the evolutionary importance of animal behavior.

**CO5:** Discuss the concept of various behaviors – territoriality, mating, parental care, aggression, foraging, migration and navigation. Understand it's with adaptive significance and fitness

**Details:**

<b>UNIT 1</b>	<b>Emergence of evolutionary thoughts</b>	<b>05 Hours</b>
	Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection	03
	Mendelism; spontaneity of mutations; the evolutionary synthesis.	02
<b>UNIT 2</b>	<b>Origin of cells and unicellular evolution</b>	<b>06 Hours</b>
	Origin of basic biological molecules; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells.	
<b>UNIT 3</b>	<b>Paleontology and evolutionary history</b>	<b>06 Hours</b>
	The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale	03
	Origins of unicellular and multicellular organisms; major groups of plants and animals; stages in primate evolution including Homo	03
<b>UNIT 4</b>	<b>Molecular Evolution</b>	<b>07 Hours</b>
	Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; origin of new genes and proteins; gene duplication and divergence.	

<b>UNIT 5</b>	<b>The Mechanisms</b>	<b>08 Hours</b>
	Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift	04
	Adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.	04
<b>UNIT 6</b>	<b>Brain, Behavior and Evolution</b>	<b>10 Hours</b>
	Approaches and methods in study of behavior; proximate and ultimate causation; altruism and evolution-group selection, kin selection	05
	Neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior; social communication; social dominance	05
<b>UNIT 7</b>	<b>Ethology</b>	<b>10 Hours</b>
	Use of space and territoriality; mating systems, parental investment and reproductive success; parental care; aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes.	

**References:**

1. An introduction to animal behaviour - Aubrey Manning
2. Genetics and the origin of species – Dobzhansky. T
3. Principles of Genetics – Dunn, Dobzhansky and Sinnott

## EC 06: Evolution and Ethology - Tutorial

S.No.	Title	Remarks
1	Screening of David Attenborough Documentary - Deep Ocean: Lost World of The Pacific Part 1 & 2 <a href="https://www.youtube.com/watch?v=Va_C_ceDaFk&amp;list=PLz58QJ68R9CSw5YUr1oAjD9dXDj8qbKrw&amp;index=5">https://www.youtube.com/watch?v=Va_C_ceDaFk&amp;list=PLz58QJ68R9CSw5YUr1oAjD9dXDj8qbKrw&amp;index=5</a>	Screening of documentary and critical comments on the same
2	David Attenborough Desert Seas National Geographic HD <a href="https://www.youtube.com/watch?v=TPYxbMvgR30">https://www.youtube.com/watch?v=TPYxbMvgR30</a>	
3	The First to Fly with David Attenborough <a href="https://www.youtube.com/watch?v=ZE00SaDUuLY">https://www.youtube.com/watch?v=ZE00SaDUuLY</a>	
4	Best Documentary HD Bringing Up Baby - BBC HD With David Attenborough.. <a href="https://www.youtube.com/watch?v=CX9TMSkKgU4">https://www.youtube.com/watch?v=CX9TMSkKgU4</a>	
5	Assessment of insect community on campus during different seasons	To study the diversity of insect population
6	Assessment of flowering plant community on campus during different seasons	To study the diversity of flowering plants
7	Dinosaurs during Mesozoic Era	Critical comments on the types - discussion in the class
8	Visit to Adaptation lab, National Centre for Biological Sciences (NCBS), Bengaluru	To understand the lab set up of ecology and evolutionary biology
9	Bird watching	Critical comments on the habitat and birds

**EC 06: Economic Biology****52 hrs****Objectives:**

- To teach various methods of organic substrate decomposition and its application.
- To discuss the application and significances of microbes in agriculture.
- To understand the conversion of biomass to Biofuel production.
- To have knowledge for the commercial production of economically important Insects, sea food, poultry, and dairy.
- To classify and learn the methods of mushroom cultivation.

**Course Outcomes**

**CO1:** Describe the methods of organic substrate decomposition and its application.

**CO2:** Explain the application and significances of microbes in agriculture.

**CO3:** Explain the methods used for the conversion of biomass to biofuel production.

**CO4:** Illustrate the commercial production of economically important Insects, sea food, poultry, and dairy.

**CO5:** Explain the methods of mushroom cultivation.

**Details:**

<b>UNIT I</b>	<b>Agricultural Biology</b>	<b>08Hours</b>
	Production of Bio – fertilizer – Nitrogen fixers and Phosphate solubilizers, AM fungi, Actinorhiza, Spirulina and Azolla.	03
	Bio – pesticide – Bacteria, Virus, IPM and its importance and application, recent trends in pest control – pheromones, attractants, repellants and chemosterilants,	03
	Vermiculture and vermicomposting – Collection of material, decomposition, types of earthworms, mass multiplication, applications of vermicompost and vermiwash.	02
<b>UNIT II</b>	<b>Economic benefits of plant and plant by products</b>	<b>06</b>
	Floriculture and horticulture – micropropagation of orchids and banana	03
	By products of plants: essential oils, aromatic oils, secondary metabolites.	03

<b>UNIT III</b>	<b>Biofuel and bioenergy</b>	<b>07</b>
	Biomass conversion to biofuel: thermochemical conversion, syngas fermentation Biochemical conversion to ethanol: biomass pretreatment Biodiesel production from oil seeds, waste oils and algae	
<b>UNIT IV</b>	<b>Beneficial Insects</b>	<b>07</b>
	Apiculture – study of life cycle, maintenance, production, diseases and control, Medicinal value of honey	04
	Sericulture – Production, silkworm as bioreactor, Economic importance of sericulture in India.	03
<b>UNIT V</b>	<b>Economic Aquaculture</b>	<b>08</b>
	Pisciculture – Techniques of induced breeding commercial culture of catla and cat – fish. By – products of fishing and its commercial values.	04
	Prawn culture – Culture techniques of fresh water and marine water prawn. Preservation and export techniques.	04
	Pearl Culture – Formation of natural pearls, commercial importance of pearl culture in India	
<b>UNIT VI</b>	<b>Economics of Poultry keeping and live-stock development</b>	<b>08</b>
	Poultry – morphology of different breeds of chicken, processing of egg, meat and by – product of poultry	02
	Dairy farm management, cross breeds of cows and buffaloes Sheep farming – Indigenous and Exotic breeds of sheep	02
	Future strategies – genetic improvement of breeds – economic importance of dairy, leather, wool, fur and pharmaceutical industries in India.	04
<b>UNIT VII</b>	<b>Vegetable Meat Cultivation</b>	<b>08</b>
	General Characters and Classification of Edible Mushrooms.	02
	Preparations for Mushroom culture – Bed preparation – Nutrients preparation climatic conditions and parameters, Spawn preparation	02
	Cultivation of Edible Mushrooms such as, <i>Agaricus bisporus</i> , <i>Pleurotus sp.</i>	02
	Nutritive values of Edible Mushrooms	02

**References:**

1. Text book of applied Zoology, vermiculture, apiculture, lac-culture, sericulture, agriculture, pests and their control. P.V.Jabde, Discovery Pub.House 2005
2. A text book of aquaculture. M.S. Reddy, Discovery Pub.House 2004
3. Insect world. J.P. Wood, Vol. I & II, Academic Press, New york 1993.
4. Development of Sericulture. M.L.Narasaiah, Discovery Pub. House 2005
5. Eartworms in agriculture. Talashikar, S.C. & A.A.K. Dosni, Daya Pub.2005
6. Garden flowers and their cultivation. Shirely, H.Daya Pub, 2006
7. Beneficial fungi and their utilization. M.C. Nair, Oscar Pub. New Delhi 2005
8. Breeding of crop plants. Hayes, H.K. & Garber, D.J. Oscar Pub. New Delhi 2005

**EC 06: Economic Biology - Tutorial**

S.No.	Title	Remarks
1	Sericulture – Online Audio-visual video on the rearing of silk worm, silk production and its economic importance <a href="https://youtu.be/cTiDbl_KHII">https://youtu.be/cTiDbl_KHII</a>	Screening of documentary and critical comments on the same
2	Pearl Culture - Online Audio-visual video on the natural formation of pearl, Commercial production and its economic importance <a href="https://www.youtube.com/watch?v=3tfcY02avW0">https://www.youtube.com/watch?v=3tfcY02avW0</a>	
3	Dairy farm management – Field visit to NDRI, Adugodi, Bengaluru/ Online Audio-visual video on economically important breeds of cows, cross breeding for high milk production and their maintenance <a href="https://youtu.be/eLKScfjYhac">https://youtu.be/eLKScfjYhac</a>	
5	Preparation, application and evaluation of Bioinoculants: Rhizobium / Azotobacter	To visualize and record the influence of Bio inoculants on plant growth and yield
6	Study of different Earthworms, Production of vermicompost (on litter and Kitchen waste) and evaluation of vermicompost on plant growth and yield	To study the bioconversion of biological waste to compost and evaluation of Vermicompost
7	Solvent extraction of essential oils from citrus leaves and study of its antimicrobial activity	To study the medicinal properties of essential oils
8	Biochemical conversion to Ethanol and Biodiesel production – Field visit to GKVK, Bengaluru	To understand the raw materials used, pre-requisites and the rate of conversion/yield
9	Cultivation of Edible Mushrooms (Oyster Mushroom)	To study the role of Mushroom as single cell protein

**EC-07: r-DNA Technology****52 hours****Objectives:**

To familiarize the student with emerging field of biotechnology i.e. Recombinant DNA Technology as well as to create understanding and expertise in wet lab techniques in genetic engineering.

**Course Outcomes**

**CO1:** Appreciate the scope and importance of recombinant DNA technology

**CO2:** Comprehend the methods used to analyze nucleic acids and proteins.

**CO3:** Understand the various vectors, hosts and tools used in molecular cloning.

**CO4:** Learn about the methods in labeling nucleic acids and proteins.

**CO5:** Describe the methods used to construct and screen DNA libraries

**CO6:** Understand the principle and procedure involved in various techniques used in recombinant DNA technology

<b>UNIT I</b>	<b>Analysis of nucleic acids and proteins</b>	<b>10 Hours</b>
	Analysis of DNA and RNA by Southern and Northern blotting techniques; DNA sequencing methods, strategies for genome sequencing.	5 hrs
	Analysis of proteins by one- and two-dimensional gel electrophoresis; Isoelectric focusing gels and western blotting. Protein sequencing methods, detection of post translational modifications of proteins.	5 hrs
<b>UNIT II</b>	<b>Vectors and Hosts used in Cloning</b>	<b>10 Hours</b>
	<b>Hosts</b> - <i>E. coli</i> strains (DH 5 $\alpha$ , BL21DE3); Yeast ( <i>Saccharomyces cerevisiae</i> , <i>Pichia pastoris</i> )	3 hrs
	<b>Vectors</b> – Cloning and expression vectors: Plasmids – pBR322, pUC18 and pUC19, pET, Ti plasmids; Phage vectors – lambda, M13; Yeast artificial chromosomal vectors (YAC), Bacterial Artificial Chromosome (BAC) Vectors for animals – SV40, Retrovirus.	7 hrs
<b>UNIT III</b>	<b>Molecular Cloning</b>	<b>09 Hours</b>
	Types of restriction endonucleases, ligases, transcriptase and polymerases. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.	4 hrs
	Methods of gene transfer; Determination of transformation/ transfection efficiency. Recombinant lambda vectors; <i>In vitro</i> packaging of lambda DNA using packaging extracts; infection of bacteria using packaged lambda viruses containing recombinant DNA.	5 hrs
<b>UNIT IV</b>	<b>Labeling of Nucleic Acids</b>	<b>05 Hours</b>



	Labelling of DNA, RNA and proteins. Use of radioactive isotopes - Nick translation, random primer labelling. Non – radioactive labelling. Relative advantages and disadvantages.	
<b>UNIT V</b>	<b>Gene Libraries</b>	<b>06 Hours</b>
	Preparation of cDNA libraries; isolation and purification of mRNA; importance of poly - A tailing in the preparation of cDNA library. Screening of cDNA libraries.	3 hrs
	Genomic library isolation and purification of total genomic DNA, partial digestion with suitable enzyme. Screening of genomic DNA libraries.	3 hrs
<b>UNIT VI</b>	<b>r-DNA Techniques-I</b>	<b>6 Hours</b>
	Polymerase Chain Reaction, RT-PCR and principles of real time PCR. Gel retardation assays (EMSA-Electrophoretic Mobility Shift Assay), DNA foot- printing by DNase I, Atomic Force Microscopy (AFM).	
<b>UNIT VII</b>	<b>r-DNA Techniques-II</b>	<b>6 Hours</b>
	Chromosome walking, DNA fingerprinting by RFLP, RAPD and AFLP, DNA microarray, <i>in situ</i> localization by techniques such as FISH and GISH.	

**References:**

1. T. A. Brown. “Gene cloning and DNA analysis - An Introduction”. 6<sup>th</sup> Ed.
2. Glick, B. R. and Pasternak, J. J. “Molecular Biotechnology: Principles and Applications of Recombinant DNA”. 2nd Ed. (1998) ASM Press Washington DC.
3. Ahluwalia, K. B. “Genetic Engineering”. (2002). New Age International (P) Ltd.
4. Glover and Hames. “DNA cloning: A Practical Approach”. (2001) Oxford Univ. Press.
5. Kingsman and Kingsman Genetic Engineering: An introduction to Gene analysis and exploitation in eukaryotes. (1998) Blackwell Scientific Publication, Oxford.