B.Sc. (Hons.) Microbiology

Detailed Syllabus

Programme Code: MCRB
Duration: 3 Years

EFFECTIVE FROM SESSION: 2019-2020

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

About the Programme

The B. Sc. (Hons.) Microbiology programme is aimed at imparting knowledge on the fundamental principles of Microbiology. This programme is beneficial for the students in the area of higher studies, career opportunities in both private and public sectors.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):

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

PEO1	Demonstrate advanced knowledge and understand the central facts and concepts of microbiology.
PEO2	Acquire knowledge and understanding of organism biology and genetics, evolution, molecular biology and basic biological chemistry.
PEO3	Instill the intellectual skills to analyze and solve biology-related problem, formulate and test hypothesis using experimental design.
PEO4	Demonstrate an understanding of professional ethics in science and of the principles that can guide ethical decision-making in biological controversies.
PEO5	Explore the scientific literature effectively and use computational tools.
PEO6	Communicate ideas and principles effectively through oral presentations, computer based tools and written reports.
PEO7	Manage resources, time and work independently as well as in multi-disciplinary team towards a common goal/outcomes.

PROGRAMME OUTCOMES (PO):

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

PO1	Understand various kinds of prokaryotic & eukaryotic microbes and their interactions
PO2	Explain and describe importance of organic compounds and its chemistry found in living cells
PO3	Understand and explain various processes of metabolism of carbohydrates amino acids and vitamins
PO4	Explain DNA, RNA and protein structure and their synthesis
PO5	Understand the concept of disease development, spread, control and eradication from society Understand the basic concepts of gene and their regulation of action
PO6	Explain and write various industrial fermentations and bioinstrumentation.

SEMESTER I

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BCHB1010	Biochemistry & Metabolism	4	0	0	30	70	100	4
DSC	BINB1020	Cell Biology	4	0	0	30	70	100	4
GE	**	Generic Elective - I	4	0/ 1	4/ 0	30	70	100	4
AECC	ENGG1000	English Communication	2	0	0	15	35	50	2
DSC	BCHB1011	Biochemistry lab	0	0	4	15	35	50	2
DSC	BINB2011	Cell Biology Lab	0	0	4	15	35	50	2
GE	**	Generic Elective - I Lab	0	1/ 0	0/ 4	15	35	50	2
		Total	**1 4**	**0**	**12**	**15 0**	**35 0**	**500**	**20**

Ability Enhancement Compulsory Courses (AECC)

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

BCHB1010	Biochemistry & Metabolism	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems. .
2. To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively

3. To Understand the importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions.

UNIT 1: Chemical constituents of Life I: **(12 Lectures)**

1.1. Amino acids: Structure & Function. Structure and properties of Amino acids

1.2. Proteins**:** Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

1.3.Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT 2: Chemical constituents of Life II **12 lectures**

2.1. Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

2.2. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids,

2.3. Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides,

2.4. Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT 3 : Bioenergenetics **(12 lectures)**

3.1. Laws of thermodynamics,

3.2. concept of free energy, endergonic and exergonic reactions, coupled reactions,

3.3. Redox reactions.

3.4. ATP: structure, its role as a energy currency molecule.

UNIT 4: Enzymes **(12 lectures)**

4.1. Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group;

4.2. Classification of enzymes

4.3. Features of active site, substrate specificity,

4.4. Mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

UNIT 5: Carbohydrates Metabolism **12 lectures**

5.1. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions.

5.2. Pentose phosphate pathway and its significance,

5.3. Gluconeogenesis Glycogenolysis and glycogen synthesis.

5.4. TCA cycle, Electron Transport Chain, Oxidative phosphorylation

Text /Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman
2. and Co.

3. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of
4. Plants. American Society of Plant Biologists.
5. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH
6. Freeman and Company, New York, USA.
7. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
8. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Course Outcomes:

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

1. Develop an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.
2. Gain proficiency in basic laboratory techniques in both chemistry and biology, and be able to apply the scientific method to the processes of experimentation and hypothesis testing

BCHB1011	**Biochemistry & Metabolism Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Quantitative estimation of RNA by orcinol reagent.
2. Quantitative estimation of DNA by DPA method.
3. Principles of Colorimetry**: (i)** Verification of Beer's law, **(ii)** To study relation between absorbance and % transmission.
4. Preparation of buffers.
5. Isolation of casein from milk.
6. Separation of sugars/amino acids by paper chromatography.
7. Qualitative tests for Carbohydrates, lipids and proteins
8. Determination of acid number of fats.

BINB1020	**Biomolecules and Cell Biology**	**4L:0T:0P**	**4 Credits**

Course objectives:

The objectives of this course are

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

UNIT 1: Biomolecules **(12 lectures)**

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

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

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

1.4. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

UNIT 2: The cell (12 lectures)

2.1. Cell as a unit of structure and function;

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

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

UNIT 3: Cell organelles (12 lectures)

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

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

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

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

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

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

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

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

4.3. Apoptosis

UNIT 5: Tools of cell biology (12 lectures)

5.1. Light Microscope- phase contrast and dark field

5.2. Chromatography

5.3. Cell culture

5.4. Cell fractionation- centrifugation

Text /Reference Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Course Outcomes:

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

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

BINB1021	**Biomolecules and Cell Biology Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

SEMESTER II

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MCRB2010	Introduction to Microbiology and Microbial Diversity	4	0	0	30	70	100	4
DSC	MCRB2020	Bacteriology	4	0	0	30	70	100	4
GE	**	Generic Elective - II	4	0/1	4/0	30	70	100	4
AECC	EVSG2000	Environmental Studies	2	0	0	15	35	50	2
DSC	MCRB2011	Introduction to Microbiology and Microbial Diversity lab	0	0	4	15	35	50	2
DSC	MCRB2021	Bacteriology lab	0	0	4	15	35	50	2
GE	**	Generic Elective - II Lab	0	1/0	0/4	15	35	50	2
		Total	**14**	**0**	**12**	**150**	**350**	**500**	**20**

Ability Enhancement Compulsory Courses (AECC)

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

MCRB2010	Introduction to Microbiology and Microbial Diversity	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

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

5. To understand the concepts of fight against major killer diseases – tuberculosis, HIV and malaria.

Unit 1: Introduction to Microbiology(12 lectures)

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

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

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

Unit 3: Staining methods(12 lectures)

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

Unit 4: Microbial growth(12 lectures)

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

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

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

Text /Reference Books:

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

Course Outcomes:

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

1. Usage of scientific terminologies to describe & express fundamental concepts in Microbiology.
2. Able to apply basic principles to understand host-microbe relationship in different Infectious diseases.
3. Able to connect and integrate the knowledge obtained for applications related to Microbes, their tools and database.

4. Able to connect and integrate the knowledge of microbiology and immunology from the perspective of a bioinformatician with special emphasis on microbe-immune interface

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

LIST OF EXPERIMENTS:

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts
9. Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts
10. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium Motility test
11. Sterilization of Laboratory Glassware and Media using Autoclave
12. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar
13. Isolation of Organisms , Macroscopic and microscopic studies: T-streak, Polygon method, Colony characteristics of microorganisms
14. Enumeration of microorganisms: Serial Dilution, Pour Plate, Spread Plate Method, Nephlometry, Haemocytometry, Breeds count
15. Growth Curve of E.coli
16. Effect of pH and temperature on growth of organisms

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

Course learning objectives:

The objectives of this course are

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

Detailed Syllabus:

Unit 1 Bacteriological techniques Lectures: 5

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

Unit 2 Microscopy Lectures: 6

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

Unit 3 Reproduction in Bacteria Lectures: 3

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

Unit 4Bacterial Systematics Lectures: 8

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

Unit 5 Important archaeal and eubacterial groups Lectures: 16

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

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

Text /Reference Books:

1. Atlas RM. (1997). Principles of Microbiology.
2. 2nd edition. WM.T.Brown Publishers. 2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. **(2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited**

Course Outcomes:

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

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

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

LIST OF EXPERIMENTS:

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

11. Motility by hanging drop method.

SEMESTER III

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MCRB3010	Virology	4	0	0	30	70	100	4
DSC	MCRB3020	Microbial Physiology and Metabolism	4	0	0	30	70	100	4
DSC	MCRB3030	Medical Microbiology	4	0	0	30	70	100	4
GE	**	Generic Elective – III	4	0/1	4/0	30	70	100	4
DSC	MCRB3011	Virology	0	0	4	15	35	50	2
DSC	MCRB3021	Microbial Physiology and Metabolism	0	0	4	15	35	50	2
DSC	MCRB3031	Medical Microbiology	0	0	4	15	35	50	2
GE	**	Generic Elective – III	0	1/0	0/4	15	35	50	2
SEC	**	Skill Enhancement Course-I	0	0	2	15	35	50	2
		Total	**16**	**0**	**22**	**185**	**455**	**650**	**26**

MCRB3010	Virology	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To acquaint students with the structure of viruses of plants, animals, and bacteria, their genome organization, and replication strategies within the host cell.
2. To learn how they evolve, spread and cause disease, and prevention and control methods for the same.
3. To describe of oncogenic viruses and their role in cancers, and emerging viruses in context of threat to public health and their management.

Unit 1 Nature and Properties of Viruses Lectures: 12

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification

and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit 2 Bacteriophages Lectures: 10

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication Lectures: 20

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions

Unit 4 Viruses and Cancer Lectures: 6

Introduction to oncogenic viruses Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5 Prevention & control of viral diseases Lectures: 8

Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination

Text /Reference Books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.

5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers. .
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

Course Outcomes:

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

1. Will be able to describe the nature, properties and structure of viruses and will also gain knowledge of taxonomy of different groups of viruses
2. Will be familiar with diversity and multiplication of lytic and lysogenic bacteriophages.
3. Will be able to describe different ways of viral transmission, and prominent and unusual genomic features of different viruses with their significance.
4. Will understand about the replication strategies, maturation and release of important plant, animal and bacterial viruses.
5. Will have gained knowledge about strategies to prevent viral infections: interferons, vaccines and antiviral compounds
6. Will understand the concept of oncogenesis, DNA and RNA cancer causing viruses and will learn of newly emerging viruses which have the potential to cause serious threats to public health and have become a global concern.

MCRB3011	Virology Lab	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique

6. Study of cytopathic effects of viruses using photographs 7. Perform local lesion technique for assaying plant viruses.

MCRB3020	Microbial Physiology and Metabolism	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To give students a comprehensive insight into various aspects of microbial physiology and metabolism.
2. To study transport mechanisms present in microbes for the uptake of nutrients, bacterial growth and factors affecting it, and diverse metabolic pathways existing in microbes for energy production and carbon and nitrogen assimilation.
3. To build the strong foundation needed by the students for further studies in the field of microbiology

2. Detailed Syllabus:

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth Lectures: 12

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 2 Nutrient uptake and Transport Lectures: 10

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration Lectures: 16

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation Lectures: 6

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate

reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism Lectures: 10 Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Text /Reference Books:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Course Outcomes:

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

1. Will have got acquainted with the diverse physiological groups of bacteria/archaea and microbial transport systems.
2. Will have an in-depth knowledge of patterns of bacterial growth, bacterial growth curve, calculation of generation time and specific growth rate, and effect of the environment on growth.
3. Will understand the variety of pathways used by bacteria for energy generation and conservation during growth on glucose under aerobic and anaerobic conditions.
4. Will become conversant with two important fermentation pathways in microbes.
5. Will have an added knowledge on the groups and families of chemolithotrophs and phototrophs, based on their ability to extract energy from inorganic compounds and assimilate carbon from

MCRB3021	**Microbial Physiology and Metabolism Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of E. coli
4. Effect of pH on growth of E. coli
5. Effect of carbon and nitrogen sources on growth of E.coli
6. Effect of salt on growth of E. coli
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of E. coli.

MCRB3030	**Medical Microbiology**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To introduce and acquaint the students with the key aspects of medical microbiology related to the diverse microbial pathogens, their virulence mechanisms, diagnostic methods and brief outline of the functional aspects of antimicrobial chemotherapy.
2. To deals with the recent development of new molecular diagnostic methods and the global spread and re-emergence of infectious diseases.

Detailed Syllabus:

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

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

Unit 2 Sample collection, transport and diagnosis Lectures: 5

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

Unit 3 Bacterial diseases Lectures: 15

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

Unit 4 Viral diseases Lectures: 14

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

Unit 5 Protozoan and Fungal diseases Lectures: 5

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

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis

Text /Reference Books:

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

Course Outcomes:

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

1. Will have gained an in depth knowledge about the spectrum of diseases caused by bacterial pathogens, and an understanding of the course of disease development and accompanying symptoms.

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

MCRB3030	**Medical Microbiology lab**	**0L:0T:4P**	**2 Credits**

SUGGESTIVE LIST OF EXPERIMENTS:

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

SEMESTER IV

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BTEB4030	Molecular biology	4	0	0	30	70	100	4
DSC	MCRB4010	Environmental Microbiology	4	0	0	30	70	100	4
DSC	MCRB4020	Food and Dairy Microbiology	4	0	0	30	70	100	4
GE	**	Generic Elective - III	4	0/1	4/0	30	70	100	4
DSC	BTEB4031	Molecular biology	0	0	4	15	35	50	2
DSC	MCRB4011	Environmental Microbiology	0	0	4	15	35	50	2
DSC	MCRB4021	Food and Dairy Microbiology	0	0	4	15	35	50	2

GE	**	Generic Elective – III Lab	0	1/0	0/4	15	35	50	2
SEC	**	Skill Enhancement Course-II	0	0	2	15	35	50	2
		Total	**16**	**0**	**22**	**185**	**455**	**650**	**26**

BTEB4030	**Molecular biology**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

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

Detailed Syllabus:

Unit 1 Hereditary material- DNA (12 lectures)

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

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

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

1.4. Cot value.

Unit 2 DNA replication in prokaryotes (12 lectures)

2.1. DNA Replication in Prokaryotes - Semi-conservative DNA replication,
2.2. DNA Polymerases and its role, E.coli Chromosome Replication,
2.3.Bidirectional Replication of Circular DNA molecules.
2.4. Rolling Circle Replication, DNA

Unit 3 DNA replication (12 lectures)

3.1. Replication in Eukaryotes
3.2. DNA Recombination –Holliday Model for Recombination
3.3. Transformation

Unit 4 Mutations(12 lectures

4.1. Definition and Types of Mutations.
4.2. Mutagenesis and Mutagens.(Examples of Physical, Chemical and Biological Mutagens)
4.3. Types of Point Mutations,
1.1. DNA REPAIR Photoreversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair**.**

Unit 5 Genetic and Chromosomal variation (12 lectures)

5.1. Genetic variation and chromosomal basis of inheritance Types: Discontinuous and continuous
5.2. Molecular basis of allelic variation.
5.3. Historical development of chromosomal theory, nature of chromosome, chromosomal behaviour 5.4. Inheritance in eukaryotes

Text /Reference Books:

1. Upadhya- Molecular Biology- Himalaya pub.
2. Watson – Molecular biology of gene- Pearson pub.

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

Genome- T.A. Brown- John Wiley

Course Outcomes:

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

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

BTEB4031	**Molecular biology lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

MCRB4010	Environmental Microbiology	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

1. To have in-depth knowledge of microbial diversity in different habitats with emphasis on their interactions among themselves and with higher plants and animals.
2. To learn about various environment-related problems and be motivated to think about sustainable and novel ways to solve them.

Unit 1 Microorganisms and their Habitats Lectures: 14

Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic &

osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

Unit 2 Microbial Interactions Lectures: 12

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 Biogeochemical Cycling Lectures: 12

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese

Unit 4 Waste Management Lectures: 12

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation Lectures: 5

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inroganic (metals) matter, biosurfactants

Unit 6 Water Potability Lectures: 5

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Text /Reference Books:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Course Outcomes:

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

1. Will get acquainted with natural habitats of diverse microbial population. And be familiar with microbial succession and concept of metagenomics.
2. Will understand how microbes interact among themselves and with higher plants and animals with the help of various examples.
3. Will become aware of the important role microorganisms play in bio-geochemical cycling of essential elements occurring within an ecosystem and its significance.
4. Will gain in-depth knowledge of different types of solid wastes and their management with emphasis on advantages and disadvantages of various methods used for their treatment.
5. Will acquire knowledge about composition and strength of sewage and its treatment using primary, secondary and tertiary methods.
6. Will have learnt about treatment and safety of drinking water and be conversant with different methods to test its potability.

	Environment Microbiology lab	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action. 2
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.

5. Determination of BOD of waste water sample. 6
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of Rhizobium from root nodules.

MCRB4020	Food and Dairy Microbiology	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

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

Detailed Syllabus:

Unit 1 Foods as a substrate for microorganisms Lectures: 8

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

Unit 2 Microbial spoilage of various foods Lectures: 10

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

Unit 3 Principles and methods of food preservation Lectures: 12

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

Unit 4 Fermented foods Lectures: 10

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

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

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

Text /Reference Books:

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

Course Outcomes:

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

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

MCRB4021	**Food and Dairy Microbiology lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. MBRT of milk samples and their standard plate count.

2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

SEMESTER V

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MCRB5010	Microbial Genetics	4	0	0	30	70	100	4
DSC	BTEB5030	Recombinant DNA Technology	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-I	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-II	4	0/1	4/0	30	70	100	4
DSC	MCRB5011	Microbial Genetics lab	0	0	4	15	35	50	2
DSC	BTEB5031	Recombinant DNA Technology lab	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-I Lab	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-II Lab	0	1/0	0/4	15	35	50	2
		Total	**16**	**0**	**20**	**180**	**420**	**600**	**24**

MCRB5010	Microbial Genetics	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To develop clear understanding of various aspects of microbial genetics and genomes in relation to microbial survival and propagation
2. To enable students to better understand courses taught later such as recombinant DNA technology and other allied papers.

Detailed Syllabus

Unit 1 Genome Organization and Mutations Lectures: 18

Genome organization: E. coli, Saccharomyces, Tetrahymena Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes

Unit 2 Plasmids Lectures: 10

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids **Unit 3 Mechanisms of Genetic Exchange Lectures: 12**

Transformation - Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit 4 Phage Genetics Lectures: 8

Features of T4 genetics , Genetic basis of lytic versus lysogenic switch of phage lambda

Unit 5 Transposable elements Lectures: 12

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition

Text /Reference Books:

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

Course Outcomes:

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

1. Will be acquainted with the organization of prokaryotic and eukaryotic genomes and organelle genomes in eukaryotes.
2. Will get acquainted with basic and applied aspects of mutations and mutagenesis and their importance and the role of mutator genes.
3. Will learn of the use of a microbial test in detecting the carcinogenic potential of chemicals. Will become aware of different repair mechanisms.
4. Will have learnt the role of plasmids and their types in microorganisms.
5. Will be aware of detailed mechanisms of genetic exchange in bacteria.

MCRB5010	Microbial Genetics lab	**0L:0T:2P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from E.coli
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

SEMESTER VI

Course Code	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	BTEB6030	Immunology	4	0	0	30	70	100	4
DSC	MCRB6010	Industrial Microbiology	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-III	4	0	0	30	70	100	4
DSE	**	Discipline Specific Elective-IV	4	0/1	4/0	30	70	100	4
DSC	BTEB6031	Immunology lab	0	0	4	15	35	50	2
DSC	MCRB6011	Industrial Microbiology lab	0	0	4	15	35	50	2
DSE	**	Discipline Specific Elective-III Lab	0	0	4	15	35	50	2

DSE	**	Discipline Specific Elective-IV Lab	0	1/0	0/4	15	35	50	2
		Total	**16**	**0**	**20**	**180**	**420**	**600**	**24**

BTEB6030	**Immunology**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

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

2. Detailed Syllabus

Unit 1 Introduction to Immunology (12 lectures)

1.1. Immune Response - An overview, components of mammalian immune system

1.2. Molecular structure of Immuno-globulins or Antibodies,

1.3. Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation,

1.4. Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Unit 2 Immunoglobulin regulation (12 lectures)

2.1. Regulation of immunoglobulin gene expression – clonal selection theory,

2.2. Allotypes & idiotypes, allelic exclusion immunologic memory,

2.3. Heavy chain gene transcription, genetic basis of antibody diversity,

2.4. Hypotheses (germ line & somatic mutation), antibody diversity.

Unit 3. MHC(12 lectures)

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

3.2. Antigen processing.

3.3. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition.

3.4. Autoimmune diseases, Immunodeficiency-AIDS.

Unit 4. Immunotechniques (12 lectures)

4.1. Antigen antibody interaction techniques- Precipitation Reactions: Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis

4.2. Agglutination Reactions: Passive, Reverse Passive, Agglutination Inhibition.
4.3. Coomb's Test; Complement Fixation Tests.
4.4. Synthesis of Monoclonal antibodies & Applications.

Unit 5 DNA Vaccines (12 lectures)

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

Text /Reference Books:

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

3. Course Outcomes:

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

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

BTEB6031	**Immunology Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay

5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Passive Agglutination- RA Factor Test.
8. ELISA (Kit based).
9. Dot ELISA
10. Single radial immunodiffusion
11. Ouchterlony double immunodiffusion

MCRB6010	**Industrial Microbiology**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. To acquaint students with the various aspects of industrial microbiology, different types of fermentation processes, fermenters designs and operations
2. To become familiar with mass scale culturing of microorganisms for industrial production of various biomolecules and /metabolites of industrial interest and different recovery methods in detail.
3. To learn about immobilization of enzymes and their applications.

2. Detailed Syllabus

Unit 1 Introduction to industrial microbiology Lectures: 2

Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media Lectures: 10

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameters Lectures: 12

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration Unit 4 Down-stream processing Lectures: 6 Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) Lectures: 18

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase) Wine, beer

Text /Reference Books:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA

3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Course Outcomes:

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

1. Understand the development and importance of industrial microbiology and will be conversant with different types of fermentation processes in liquid media as well as solid state substrates media.
2. Learn about the design, operation and uses of different types of fermenters of laboratory, pilot and industrial scale.
3. Gain insight into the techniques of isolation, screening, preservation and maintenance of industrially important microbial strains and different types of media used in fermentation processes.
4. Be acquainted with principles of techniques used for the extraction and purification of industrial products produced using microbial fermentation processes.
5. Gained in-depth knowledge of the principles of microbial production and recovery of industrial products at large scale

MCRB6011	**Industrial Microbiology lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzymes: Amylase and Protease (b) Amino acid: Glutamic acid (c) Organic acid: Citric acid (d) Alcohol: Ethanol
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

LIST OF GENERAL ELECTIVE SUBJECTS

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

Semester	Offering Department	Course Code (T+P)	Course Name	(L-T-P)	Credits

II	Biotechnology	BTEB2010+ BTEB2011	Introduction to Biotechnology	4-0-4	6
III	Biotechnology	BTEB3020+ BTEB3021	Immunology	4-0-4	6
IV	Biotechnology	BTEB4010+ BTEB4011	Pharmagenomics	4-0-4	6
II	Bioinformatics	BINB2010+BI NB2011	Introduction to Bioinformatics	4-0-4	6
III	Bioinformatics	BINB3010+ BINB3011	Concepts in Bioinformatics	4-0-4	6
IV	Bioinformatics	BINB4010+BI NB4011	Computer aided drug design.	4-0-4	6
I	Zoology	ZOOB1010+ ZOOB1011	Non-Chordates	4-0-4	6
II	Zoology	ZOOB2010+ ZOOB2011	Chordates	4-0-4	6
III	Zoology	ZOOB3010+ ZOOB3011	Animal Physiology: Controllong and coordinating system	4-0-4	6
IV	Zoology	BCHB4210+ BCHB4211	Biochemistry Of Metabolic Processes	4-0-4	6
II	Biochemistry	BCHB2020+ BCHB2021	Enzymes	4-0-4	6
III	Biochemistry	BCHB3020+ BCHB3021	Membrane Biology and Bioenergetics	4-0-4	6
IV	Biochemistry	BCHB4030+ BCHB4031	Hormone: Biochemistry and Function	4-0-4	6
I	Botany	MCRB1010+ MCRB1011	Microbiology and Phycology	4-0-4	6
II	Botany	BOTB2010+ BOTB2011	Diversity of Archaegoniates&Plan t Anatomy	4-0-4	6
III	Botany	BOTB3020+ BOTB2021	Economic botany	4-0-4	6

IV	Botany	BOTB4020+ BOTB4021	Phytogeography	4-0-4	6
I	Chemistry	CHYB1010 + CHYB1011	Inorganic Chemistry	4-0-4	6
II	Chemistry	CHYB2010 + CHYB2011	Organic Chemistry	4-0-4	6
III	Chemistry	CHYB3010 + CHYB3011	Physical Chemistry	4-0-4	6
IV	Chemistry	CHYB4010 + CHYB4011	Basic Analytical Chemistry	4-0-4	6

----------BOTANY ----------

	Microbiology and Phycology	**5L:1T:0P**	**6 Credits**

Course objectives:

The objectives of this course are

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

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

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

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

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

UNIT- 2 : VIRUSES (12 Lectures)

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

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

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

UNIT 3: BACTERIA (12 Lectures)

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

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

3.3. Economic importance of Bacteria.

UNIT –4: ALGAE (12Lectures)

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

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

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

UNIT 5: FUNGI (12 Lectures)

5.1. General characteristics and outline classification (Ainsworth).

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

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

Text /Reference Books:

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

Course Outcomes:

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

1. Develop understanding on the concept of microbial nutrition
2. Classify viruses based on their characteristics and structures
3. Develop critical understanding of plant diseases and their remediation.
4. Examine the general characteristics of bacteria and their cell reproduction/ recombination
5. Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance
6. Conduct experiments using skills appropriate to subdivisions

	Microbiology and Phycology Lab		**4 Credits**

LIST OF EXPERIMENTS:

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

	Diversity of Archaegoniates &Plant Anatomy	**4L:0T:2P**	**6 Credits**

Course Objectives:

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

UNIT – 1: BRYOPHYTES (12Lectures)

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

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

1.3. Evolution of Sporophyte in Bryophytes.

UNIT – 2: PTERIDOPHYTES (12Lectures)

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

2.2. Structure, reproduction and life history of Lycopodium, and Marsilea.

2.3. Heterospory and seed habit.

2.4. Evolution of stele in Pteridophytes.

UNIT – 3: GYMNOSPERMS (12Lectures)

3.1. Gymnosperms: General characters, classification (up to classes)

3.2. Morphology, anatomy, reproduction and life history of Pinus and Gnetum

3.3. Economic importance with reference to wood, essential oils and drugs

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

4.1.Meristems - Root and Shoot apical meristems and their histological organization.

4.2.Tissues – Meristematic and permanent tissues (simple, complex, secretory)

4.3.Tissue systems–Epidermal, ground and vascular.

UNIT – 5. Secondary growth (12Lectures)

5.1. Anomalous secondary growth in Achyranthes, Boerhaavia and Dracaena.

5.2. Study of local timbers of economic importance-Teak, Rosewood, Red sanders and Arjun (Tella maddi).

Course Learning Outcomes:

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

Text /Reference Books

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

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

	Diversity of Archaegoniates &Plant Anatomy Lab	**0L:0T:2P**	**4 Credits**

LIST OF EXPERIMENTS

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria:* Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of *Stemonitis* sporangia.
9. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.

10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

	Economic botany	**4L:0T:2P**	**5 Credits**

COURSE OBJECTIVES

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

Unit 1: Origin of Cultivated Plants (6 lectures)

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

Unit 2: Cereals and Legumes (6 lectures)

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

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

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

Unit 4 : Spices and Beverages (6 lectures)

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

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

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

COURSE OUTCOME

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

5. Appreciate the diversity of plants and the plant products in human use

Text/ Reference Books

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

	Economic Botany lab	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1) **Cereals**: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2) **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3) **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice- micro-chemical tests),
4) Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
5) **Spices:** Black pepper, Fennel and Clove (habit and sections).
6) **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
7) **Sources of oils and fats**: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
8) **Essential oil-yielding plants**: Habit sketch of *Rosa*, *Vetiveria, Santalum* and *Eucalyptus* (specimens/photographs).

	Phytogeography	**4L:0T:2P**	**5 Credits**

COURSEOBJECTIVE

1. To give a fundamental understanding of the distribution of vascular plants and of the basic models which describe it.
2. To know about the floristic regions and plant formations of the Planet, in the light of previous continental and climatic evolution.
3. To learn floristic recording of specific habitats and the assessment of their naturality on the basis of chorological and life form spectra of the flora.

Unit I: Introduction, soil and water 15 lectures

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

Unit II: Ecological adaptations, Population ecology 15 lectures

Variations in adaptation of plants in relation to light, temperature, water, wind and fire. Biotic interactions: Competition: Inter- and intraspecific competition; Ammensalism, heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation, Population ecology: Characteristics

and population growth, population regulation, life history strategies; *r* and *k* selection. Ecological Speciation.

Unit III: Plant Communities and Ecosystem 15 lectures

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

Unit IV: Functional Aspects of Ecosystem and Phytogeography 15 lectures

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

Course outcomes

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

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

Text/ Reference Books

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

	Phytogeography lab	**4L:0T:2P**	**5 Credits**

LIST OF EXPERIMENTS:

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (with pH meter, universal indicator/Lovibond comparator and/or pH paper strip)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid
5. titration method.
6. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
7. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
8. Study of morphological adaptations of hydrophytes and xerophytes (four each).
9. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).

10. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
11. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

----------**ZOOLOGY**----------

	NON-CHORDATES : PROTISTS TO ECHINODERMATA	**4L:0T:2P**	**5 Credits**

Course Objectives:

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

Unit 1: Protista, Parazoa and Metazoa 12 lectures

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

Unit 2: Porifera and Cnidaria 12 lectures

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

Unit 3: Helmimthes, Platyhelminthes and Annelida 12 lectures

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

Unit 4: Arthropoda 12 lectures

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

Unit 5 Mollusca and Echinodermata 12 lectures

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

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

1. Student should be able to describe unique characters of protozoa to echinodermata
2. Student should be able to recognize life functions of protozo to echinodermata
3. To recognise the ecological role of phylum protozoa to echinodermata
4. **T**o recognise the diversity from protozoa to echinodermata

Text /Reference Books:

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

	Non Chordates Lab	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

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

	Chordates	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVES

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

UNIT 1:

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

Unit – 2:

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

Unit – 3:

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

Unit :4 Aves

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

Unit -5 Mammalia

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

COURSE OUTCOME

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

Text Books/ Reference Books

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

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

	Chordates Lab	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

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

	Animal Physiology: Controlling and coordinating system	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVE

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

Unit 1: Tissues

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

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

Unit 2: Nervous System

2.1. Structure of neuron, resting membrane potential,

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

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

Unit 3: Muscle Histology of different types of muscle;

3.1. Ultra structure of skeletal muscle;
3.2 Molecular and chemical basis of muscle contraction;
3.3. Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 4: Reproductive System

4.1. Histology of testis and ovary;
4.2. Physiology of male and female reproduction; Puberty,
4.3. Methods of contraception in male and female

Unit 5 : Endocrine System

5.1. Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action;
5.2. Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones;
5.3. Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones

COURSE OUTCOME

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

TEXT / REFERENCE BOOKS

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

		0L:0T:2P	**1 Credits**

LIST OF EXPERIMENTS

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)

3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues (*Subject to UGC guidelines)

	Biochemistry Of Metabolic Processes	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVES

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

Unit 1: Overview of Metabolism

1.1 Catabolism vs Anabolism, Stages of catabolism,
1.2. Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions;
1.3. Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

2.1. Sequence of reactions and regulation of glycolysis, Citric acid cycle,
2.2. Phosphate pentose pathway,
2.3. Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism

3.1. β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms;
3.2.Biosynthesis of palmitic acid;
3.3. Ketogenesis

Unit 4: Protein Metabolism

4.1. Catabolism of amino acids: Transamination, Deamination,
4.2. Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation

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

COURSE OUTCOME

1. Students gain knowledge and skill in the interactions and interdependence of physiological and biomolecules and the understand essentials of the metabolic pathways along with their regulation.

2. To understand the principles, instrumentation and applications of bioanalytical techniques.
3. To expose the students to various processes used in industries.
4. Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation and be able to design and conduct scientific experiments and analyze the resulting data.

Text/ Reference Books

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

	Biochemistry Of Metabolic Processes Lab	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS:

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

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

	Introduction to Biotechnology	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVE

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

Unit 1: History & Introduction to Biotechnology **12L**

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

Industrial Biotechnology, Pharmaceutical Biotechnology, Environmental Biotechnology. Biotechnology Research in India. Biotechnology Institutions I n India (Public and Private Sector)

Unit 2: Healthcare Biotechnology **12 L**

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

Unit 3: Food Biotechnology **12L**

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

Unit 4: Agriculture biotechnology **12L**

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

Unit 5: Marine Biotechnology

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

COURSE OUTCOME

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

Text/ References

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

	Introduction to Biotechnology **Lab**	**0L:0T:2P**	**1 Credits**

LIST OF EXPERIMENTS

1. Detection of food adulterants.
2. Study of marine organisms.

	Immunology	**0L:0T:2P**	**1 Credits**

COURSE OBJECTIVE

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

Unit 1 Introduction to Immunology (12 lectures)

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

Unit 2 Immunoglobulin regulation (12 lectures)

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

Unit 3. MHC(12 lectures)

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

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

Unit 4. Immunotechniques (12 lectures)

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

Unit 5 DNA Vaccines (12 lectures)

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

COURSE OUTCOME

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

Text/ Reference Books

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

	Immunology Lab	**0L:0T:2P**	**1 Credits**

List of Experiments:

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

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

Course learning objectives:

The objectives of this course are

1. To understand different antimicrobial agents
2. To learn the general principles of pharmacology
3. To understand the concept of toxicology

4. To study the mechanism of drug absorption and distribution
5. To understand basic and regulatory toxicology

Detailed Syllabus:

Unit I- Chemotherapeutic agents

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

Unit 2 General principles of pharmacology

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

Unit 3 Drug Absorption and distribution

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

Unit 4 Basic and regulatory toxicology

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

Text /Reference Books:

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders
2. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition
3. Clinical Pharmacology Bennet,PN,Brown,M.J, Sharma,P 11th edition Elsevier
4. Biochemistry Metzler, D.E Elsevier
5. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill
6. Medical Microbiology Jawetz,E., Brooks,G.E, Melnick,J.L., Butel,J.S Adelberg E. A 18th edition
7. Medical Microbiology by Patrick Murray 5th edition
8. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown
9. Understanding Viruses by Teri Shors
10. Mim's Medical Microbiology 5th edition
11. Casarett & Doull's Toxicology- The Basic Science Of Poisons

Course Outcomes:

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

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

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

LIST OF EXPERIMENTS:

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

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

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

Course learning objectives:

The objectives of this course are

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

Unit 1 Enzyme kinetics Lectures: 10

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

Unit 2 Bisubstrate reactions Lectures: 2

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

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

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

Unit 4 Regulation of enzyme activity Lectures: 8

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

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

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

Text /Reference Books:

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

Course Outcomes:

At the end of this course :

1. Students will learn the nature and importance of enzymes in living systems
2. Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity
3. Students will learn about the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors
4. Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell
5. students will learn applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

BCHB2021	Enzymes	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

BCHB3020	Membrane Biology and Bioenergetics	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

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

2. Detailed Syllabus:

Unit 1 Introduction to biomembranes and Membrane Strucures Lectures: 4

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

Unit 2 Membrane dynamics Lectures: 6

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

Unit 3 Membrane transport Lectures: 10

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins**.** Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactosepermease, Na+-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Unit 4 Introduction to bioenergetics Lectures: 6

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

Unit 5 Oxidative phosphorylation Lectures : 12

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

Text /Reference Books:

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

Course Outcomes:

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

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

BCHB3021	Membrane Biology and Bioenergetics lab	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

BCHB4030	Hormone: Biochemistry and Function	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

6. To provide an understanding of the process of cellular communication including signal reception, transduction, amplification and response.

7. To imparts an understanding of the different endocrine factors that regulate metabolism, growth, ionic homeostasis, glucose homeostasis and reproductive function

Detailed Syllabus:

Unit 1 Introduction to endocrinology Lectures : 6

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

Unit 2 Hormone mediated signaling Lectures : 16

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

Unit 3 Hypothalamic and pituitary hormones Lectures : 8

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

Unit 4 Thyroid hormone Lectures : 4

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

Unit 5 Hormones regulating Ca2+ homeostasis Lectures : 6

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

Text /Reference Books:

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

Course Outcomes:

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

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

BCHB4031	Hormone: Biochemistry and Function lab	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

BIOINFORMATICS

BINB2010	**Introduction to Bioinformatics**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

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

Unit 1: Introduction (12 Lectures)

1.1. Definition ,History , branches , scope and research areas in Bioinformatics
1.2. Human genome project
1.3. Role of computer in bioinformatics
1.4. Applications and BIO-IT

Unit 2: Introduction to databases (12 Lectures)

2.1. Introduction to genomics and proteomic data, post genomic era.
2.2. Data acquisition- functions and purposes.
2.3. Biological databases- relational and object oriented concepts.
2.4. Information retrieval from biological databases- ENTREZ and SRS.
2.5. Methods for presenting large quantities of data- sequence and strucrure viewer

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

3.1. Primary and secondary database, genebanks.
3.2. EVBC nucleotide, sequence data bank-DDBJ.

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

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

Unit 4: Protein Sequence Databases (12 Lectures)

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

4.2. Motiff databases- eblocks, PROSITE

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

Unit 5: Structural Databse (12 Lectures)

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

5.2. Repository ModBase, Protein Model Portal.

5.3. Eurocarb DB, DIP, BIND, STRING.

Text /Reference Books:

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

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

Course Outcomes:

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

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

BINB2011	**Introduction to Bioinformatics Lab**	**0L:0T:4P**	**4 Credits**

LIST OF EXPERIMENTS:

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

BINB3010	**Concepts in Bioinformatics**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

1. List the concepts and applications of sequence searching
2. Define the concepts of homology, identity, orthologues, paralogues

3. Provide examples of basic sequence alignment, introducing concepts of point mutations, deletions, insertions etc.
4. Provide an outline of the different approaches to sequence alignment - exhaustive vs. heuristic

Detailed Syllabus:

Unit 1: Introduction (12 lectures)

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

Unit 2: Alignments (12 lectures)

2.1. Pairwise alignment: DotPlot analysis.
2.2. Dynamic programming- Needleman- Wunch Algorithm, Smith- Waterman algorithm, Edit distance dynamic program ming.
2.3. Clusrtal W, TCOFFEE, Profile methods- Gribskov profile, PSI_BLAST
2.4. Multiple segment alignment- sum of pairs, Divide and conquer, Progressive and Iterative alignment

Unit 3: Cluster detection (12 lectures)

3.1. Phylogenetic relationships, Clustering and Phylogeny
3.2. Phylogenetic analysis- concept of Phylogenetic tree, Methods of Phylogeny analysis- Diastance and character based methods.
3.3. Motif detection
3.4. Protein family databases.

Unit 4: Data Mining(12 lectures)

4.1. Data Mining- introduction and definition.
4.2. Data Mining problem and Data Mining Techniques, Tools and Methods.
4.3. Management of databases.
4.4. DBMS. Difference between DBMS and file system.

Unit 5 Metabolomics (12 lectures)

5.1. metabolic pathway database (KEGG pathway database)
5.2. Concept of Metablome and Metabolomics
5.3. Drug discovery and Design- target identification, target validation, lead identification, lead optimization, Priclinical Pharmacology and Toxicology.
5.4. Chemoinformatics tools for drug discovery- Chemical structure representation(SMILE & SMART), Chemical datatbases (CSD,ACD,WDI, PUBCHEM and Chembank)

Text /Reference Books:

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

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

Course Outcomes:

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

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

BINB3011	**Concepts in Bioinformatics Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

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

BINB4010	**Computer aided drug design.**	**4L:0T:0P**	**4 Credits**

Course learning objectives:

The objectives of this course are

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

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

1.1.Stages of drug discovery and development

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

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

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

Unit 2: QSAR and SAR (12 lectures)

2.1.Quantitative Structure Activity Relationship (QSAR)

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

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

Unit 3: Molecular docking (12 lectures)

3.1. MolecularModelingandVirtual Screening techniques: Drug likeness screening,

3.2. Concept of pharmacophore mapping and pharmacophore based Screening,

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

3.4. *De novo* drug design.

Unit 4: Informatics (12 lectures)

4.1.Informatics & Methods in drug design

4.2. Introduction to Bioinformatics, chemoinformatics.

4.3. ADME databases, chemical, biochemical and pharmaceutical databases.

Unit 5: Molecular Modeling (12 lectures)

5.1. Molecular Modeling: Introduction to molecular mechanics and quantum mechanics.

5.2. Energy Minimization methods and Conformational Analysis,

5.3. Global conformational minima determination.

Text /Reference Books:

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

Course Outcomes:

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

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

BINB4011	**Computer aided drug design. Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Installation of various drug design software and assignment 'Project'
2. Generation of 3D optimized structure of a "Ligand" molecule
3. Preparation of target and ligand molecules for docking
4. Virtual library Preparation" of lead molecules
5. Docking of ligands into a receptor (active site)

6. Flexible docking of ligand with target
7. Fragment docking using '*De Novo'* Receptor and '*De Novo'* Links (LUDI algorithm)
8. Pharmacophore modeling of ligands
9. Pharmacophore-based database searching and *de novo* design of ligand against an active site
10. Development of 3D QSAR model by using "Discovery Studio"
11. ADME property and toxicity predictions of lead molecule (usingTOPKAT)

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

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

Course Learning Objectives:

The objective of this course is:
1. To make student learn about wave mechanics.
2. To study about periodic properties of S,P,D & F block elements
3. To impart knowledge of covalent and ionic bond.
4. To impart knowledge of metallic bonds and weak Chemical Forces
5. To make student learn about oxidation and reduction.

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

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

Unit 2: **Periodicity of Elements:** L:16
s, *p*, *d*, *f* block elements, the long form of periodic table. Properties of the elements with reference to *s*&*p*-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) Ionic and crystal radii. Covalent radii (octahedral and tetrahedral) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Pauling's/ Mulliken's/Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

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

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

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

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

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

Text/Reference Books:

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

Course Outcomes:

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

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

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

LIST OF EXPERIMENTS:

(A) Titrimetric Analysis

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

(B) Acid-Base Titrations

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

(C) Oxidation-Reduction Titrimetry

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

Reference text:

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

Course Outcomes:

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

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

5. Understand concept of oxidation and reduction based reactions.

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

Course Learning Objectives:

The objective of this course is:

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

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

Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocation's, Carbanion, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit 2: **Carbon-Carbon sigma bonds::**L: 8

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Unit 3: **Carbon-Carbon pi bonds::**L: 14

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylicbromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

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

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

Text/Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

Course Outcomes:

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

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

5. Understand concept of aromaticity.

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

LIST OF EXPERIMENTS:

1. Checking the calibration of the thermometer

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

a. Water
b. Alcohol
c. Alcohol-Water

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

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

6. Chromatography

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

Reference Books

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

Course Outcomes:

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

1. To purify organic compounds by crystallization.

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

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

Course Learning Objectives:

The objective of this course is:

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

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

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

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

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate

expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Unit 3: **Chemical Kinetics II:** L:8
Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit 4: **Catalysis:**L:8
Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit 5: **Surface chemistry:**L:6
Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

Text/Reference Books:

- Peter Atkins & Julio De Paula, *Physical Chemistry9th Ed.*, Oxford University Press (2010).
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Zundhal, S.S. *Chemistry concepts and applications*Cengage India (2011).
- Ball, D. W. *Physical Chemistry*Cengage India (2012).
- Mortimer, R. G. *Physical Chemistry3rd Ed.*, Elsevier: NOIDA, UP (2009).
- Levine, I. N. *Physical Chemistry6th Ed.*, Tata McGraw-Hill (2011).
- Metz, C. R. *Physical Chemistry2nd Ed.*, Tata McGraw-Hill (2009).

Course Outcomes:

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

1. Students will learn about phase equilibria and binary solutions.
2. Will have idea of molecularity and rate laws.

3. Students will have idea about collision theory of reaction rates.
4. Students will understand about enzyme catalytic reaction.
5. Solve problems related to surface chemistry.

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

LIST OF EXPERIMENTS:

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

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

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

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

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

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

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

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

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

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

Text/Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R.

Chand & Co.: New Delhi (2011).

- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
- Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry3rd Ed.;* W.H. Freeman & Co.: New York (2003).

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

Course Learning Objectives:

The objective of this course is:

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

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

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

Unit 2: **Analysis of soil and water:** L: 7 Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

Determination of pH of soil samples. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.Determination of pH, acidity and alkalinity of a water sample. Determination of dissolved oxygen (DO) of a water sample.

Unit 3: **Analysis of food products**: L:6

Nutritional value of foods, idea about food processing and food preservations and adulteration.

Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

Unit 4: **Analysis of preservatives and colouring matter:** L: 6

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

Unit 5: **Suggested Applications(Any one):** L:6

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

Text/ Reference Books:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog &Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry *2nd Ed.*, W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry*, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.*, Prentice Hall.
10. Vogel, A. I. Vogel's *Quantitative Chemical Analysis6th Ed.*, Prentice Hall.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.*, Marcel Dekker, Inc., New York (1995).

Course Outcomes:

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

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

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

LIST OF EXPERIMENTS:

1. Determination of pH of soil samples.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample.

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

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

Semester	Course Code	Generic Electives	(L-T-P)	Credits
I	BCHB1010+BCHB1011	Biochemistry	4-0-2	6
I	BINB1020+BINB1021	Cell Biology	4-0-2	6
II	MCRB2010+MCRB2011	Introduction to Microbiology and Microbial Diversity	4-0-2	6
II	MCRB2020+MCRB2021	Bacteriology	4-0-2	6
III	MCRB3010+MCRB3011	Virology	4-0-2	6
III	MCRB3020+MCRB3021	Microbial Physiology and Metabolism	4-0-2	6
IV	MCRB4010+MCRB4011	Environmental Microbiology	4-0-2	6
IV	MCRB4020+MCRB4021	Food and Dairy Microbiology	4-0-2	6

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

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

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
V	MCRB5310+MCRB5311	Microbial Biotechnology	4-0-2	6
V	MCRB5320+MCRB5321	Bioinformatics	4-0-2	6
V	BINB5320+BINB5321	I.P.R. Entrepreneurship Bioetihcs& Biosafety	4-0-2	6
VI	MCRB6310+MCRB6311	Instrumentation and Biotechniques	4-0-2	6
VI	BTEB6320+BTEB6321	Bioenergy And Biofuels	4-0-2	6
VI	MCRB6320+MCRB6321	Microbes in Sustainable Agriculture and Development	4-0-2	6

MCRB5310	**Microbial Biotechnology**	**4L:0T:0P**	**4 Credits**

Course Learning Objective:

The objectives of this course are:

1. To understand the role of microorganisms in the advent of biotechnology, both traditional as well as modern.
2. To become aware of the benefits and concerns of using microbe-based procedures/tools such as biosensors, biopesticides, bioplastics, bioleaching as well as genetically modified organisms.
3. To learn about Non-traditional vaccines and the promise they hold will be discussed.
4. To learn about IPR and its main components would empower the students to protect their innovative research work in the future, and yet be able to fruitfully share with the deserving fellow users.

Detailed Syllabus

Unit 1 Microbial Biotechnology and its Applications Lectures: 10

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology Lectures: 10

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors

Unit 3 Applications of Microbes in Biotransformations Lectures: 8

Microbial based transformation of steroids and sterols Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit 4 Microbial Products and their Recovery Lectures: 10

Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization

Unit 5 Microbes for Bio-energy and Environment Lectures: 12

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

Text /Reference Books:

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

Course Outcomes:

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

1. Will get an overview of the possibility of using microbes in a number of technologies and fields for the direct/indirect benefit of mankind and the environment.
2. Will get familiarized with how manipulated producer microbes and/or procedures may yield products of medical/therapeutic value, hence contributing to human longevity.
3. Will learn how microorganisms are the mightiest candidates in fighting environmental pollution and minimizing xenobiotics, thereby elevating human living conditions. Biosensors and whole cell/enzyme immobilization would be appealing illustrations to the students as some of the strategies towards this goal.
4. Will delve deep into the role of microorganisms in maintaining environmental homeostasis, combating pollution, eliminating xenobiotics and inexpensive energy production from waste natural lignocellulosics.
5. Will become familiar with the contribution of specific microorganisms in traditional agriculture practices, and will become acquainted with GM crops, RNA interference and edible vaccines.

MCRB5311	**Microbial Biotechnology lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins

MCRB5320	**Bioinformatics**	**4L:0T:0P**	**4 Credits**

Course Learning Objective:

The objectives of this course are:

6. To Learn and understand basic concepts of Bioinformatics
7. To understand various databases.
8. To learn and understand protein databases.
9. To understand nucleic acid databases.
10. To learn about genomic databases.

Unit 1: Introduction (12 Lectures)

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

1.6. Human genome project

1.7. Role of computer in bioinformatics

1.8. Applications and BIO-IT

Unit 2: Introduction to databases (12 Lectures)

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

2.2. Data acquisition- functions and purposes.

2.3. Biological databases- relational and object oriented concepts.

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

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

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

3.1. Primary and secondary database, genebanks.

3.2. EVBC nucleotide, sequence data bank-DDBJ.

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

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

Unit 4: Protein Sequence Databases (12 Lectures)

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

4.2. Motiff databases- eblocks, PROSITE

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

Unit 5: Structural Databse (12 Lectures)

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

5.2. Repository ModBase, Protein Model Portal.

5.3. Eurocarb DB, DIP, BIND, STRING.

Text /Reference Books:

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

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

Course Outcomes:

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

4. Gain an understanding of the basic concepts of Bioinformatics and Biostatistics
5. Understand the tools used in Bioinformatics.
6. Apply the various Statistical tools for Analysis of Biological Data

MCRB5321	**Bioinformatics Lab**	**0L:0T:4P**	**4 Credits**

LIST OF EXPERIMENTS:

10. To explore NCBI.
11. To explore gene bank.
12. To explore PDB.
13. To perform sequence alignment using BLAST.
14. To access the SCOP and CATH databse to study protein classification.
15. To visualize protein using Rasmol.
16. To explore STRING database.
17. To explore secondary databse- prosite and Pfam.
18. To find protein motifs.

BINB5320	**I.P.R. Entrepreneurship Bioetihcs& Biosafety**	**4L:0T:0P**	**4 Credits**

Course Learning Objective:

The objectives of this course are:

1. To provide an insight and understanding about different aspects of protection of inventions and research developments
2. Learn about procedures for filling protection through Intellectual Property Rights.
3. To provide scopes of protection of diverse intellectual properties and its commercialization forsocio-economic improvement.

Detailed Syllabus

Unit 1. Introduction (12 lectures)

1.1.Introduction to Indian Patent Law.
1.2.World Trade Organization and its related intellectual property provisions.
1.3.Intellectual/Industrial property and its legal protection in research, design anddevelopment.
1.4. Patenting in Biotechnology, economic, ethical and depository considerations.

Unit 2. Entrepreneurship (12 lectures)

2.1. Entrepreneurship: Selection of a product, line, design and development processes
2.2. economics on basic regulations of excise:
2.3. Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

Unit 3 . Bioethics (12 lectures)

3.1. Bioethics – Necessity of Bioethics
3.2. Different paradigms of Bioethics – National & International.
3.3. Ethical issues against the molecular technologies.

Unit 4. Biosafety (12 lectures)

4.1. Biosafety– Introduction to biosafety and health hazards concerning biotechnology.
4.2. Introduction to the concept of containment level
4.3. Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

Course Outcomes:

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

1. To enable students with basic concepts and knowledge of intellectual property rights.
2. To apply and execute different types of IP protection in research and academics.
3. Able to understand about the mechanisms of different IP protections, registrations and applications Technical
4. To be capable of tackling issues related to IP and its commercialization
5. To learn the strategies for effective IP management and commercialization Analytical skills

Reference Books:

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship : Jack M. Kaplan
3. 3Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international

BINB5321	**I.P.R. Entrepreneurship Bioetihcs& Biosafety lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste

MCRB6310	**Instrumentation and Biotechniques**	**4L:0T:0P**	**4 Credits**

1. Course learning objectives:

The objectives of this course are

- To develop the skills to understand the theory and practice of bio analytical techniques.
- To provide scientific understanding of analytical techniques and detail interpretation of results.

UNIT I Microscopy

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II Centrifugation (15 Lectures)

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III Chromatography (15 Lectures)

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV Electrophoresis **(20 Lectures)**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

Text /Reference Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John
   Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.
   Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM
   Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

3. Course Outcomes:

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

1. Apprehend the functioning, maintenance and safety aspects of the basic apparatus used in a Biotechnology lab.
2. Assimilate the principles and applications of centrifuge, electrophoresis and chromatography in research and related experiments.
3. Employ the knowledge for the separation of proteins/peptides by selecting appropriate separation techniques.
4. Characterize certain functionalities of biomolecules by using spectroscopic techniques.

MCRB6311	**Instrumentation and Biotechniques lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

BTEB6320	Bioenergy And Biofuels	5L:1T:0P	4 Credits

Course Learning Objective:

The objectives of this course are:

1. Introduction of existing and possible Bioenergy and Biofuels technoloies
2. Discussion of technical, process and economic issues related to first, second and third generation biofuels along with Physico chemical techniques

Detailed Syllabus

Unit 1 Introduction to Biofuels and Bioenergy

1.1 Definition, Global Energy Outlook, Sustainability, Biomass Feedstocks, Processes and 1.2. Technologies, Environment and Ecology

Unit 2 Ethanol from Corn and Lignocellulosics:

2.1. Fuel Ethanol from Corn, Corn Ethanol as Oxygenated Fuel,

2.2. Chemistry of Ethanol Fermentation, Corn-to-Ethanol Process Technology, By-Products/Coproducts of Corn Ethanol, Ethanol as Oxygenated and Renewable Fuel, Ethanol Vehicles,

2.3. Lignocellulose and Its Utilization, Lignocellulose Conversion, Agricultural Lignocellulosic Feedstock, Cellulosic

2.4. Ethanol Technology; Energy Balance for Ethanol Production from Biomass, Process Economics and Strategic Direction.

Unit 3 Fast Pyrolysis and Gasification of Biomass:

3.1. Biomass and Its Utilization, Analysis and Composition of Biomass,

3.2. Chemistry of Biomass Gasification, Fast Pyrolysis of Biomass, Biomass Gasification Processes, 3.3. Utilization of Biomass Synthesis Gas

Unit 4 Conversion of Waste to Biofuels, Bioproducts, and Bioenergy & Mixed Feedstock:

4.1.Types of Waste and Their Distributions, Strategies for Waste Management, Waste Preparation and Pretreatment for Conversion, Technologies for Conversion of 4.2. Waste to Energy and Products, Economic and Environmental Issues Related to Waste Conversion, Future of the Waste Industry, Advantages and Disadvantages of Mixed Feedstock, Transportation, Storage, and Pretreatment,

4.3. Gasification Technologies, Liquefaction Technologies, Future of Mixed Feedstock.

Unit 5 Biomass sources:

5.1. Waste sources, liquid, solid, Agrobased sources, Energy scenarios,Biogas technology-biogas plant & types, biodigester.

5.2. Biogas- composition, production and factors affecting production, uses

5.3. Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Case studies on Biogas and biofuels, Advanced biofuels

Course Outcomes:

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

- Advantages and disadvantages of Bioenergy and Biofuels over fossil fuels
- Technical barriers in Bioenergy and Biofuel Technology
- Whole biorefinery approaches for economical implementation into the market
- Conversion technologies of waste to Biofuels, Bioproducts, and Bioenergy

- Conversion of waste and Mixed feedstock to Biofuels, Bioenergy and Bioproducts.

Reference Books:

1. Biofuels and Bioenergy: Processes and Technologies by Sunggyu Lee and Y. T. Shah, CRC Press
2. Bioenergy and Biofuel from Biowastes and Biomass by Samir K. Khanal, Rao Y. Surampalli, Tian C.Zhang, Buddhi P. Lamsal, R. D. Tyagi and C.M. Kao, ASCE Publishers .
3. Review and research articles from Science Direct, Springer, Wiley and PubMed Publishers

MCRB6320	**Microbes in Sustainable Agriculture and Development**	**4L:0T:0P**	**4 Credits**

Course Learning Objective:

The objectives of this course are:

1. To introduce students to basic characteristics of microorganisms (morphology, cytology, metabolism), their ecologies and importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products.
2. To provide students with useful information regarding the taxonomical, physiological, and environmental aspects of soil microorganisms.
3. To learn the roles of soil microbes, such as decomposing dead organic matter, enriching the soil with nutrients, increasing water infiltration, improving soil texture, etc.
4. To acquire knowledge on such topics as: organisms and interactions, mycorrhizal symbioses, biological dinitrogen fixation (both symbiotic and non-symbiotic)

Detailed Syllabus

Unit 1 Soil Lectures 5

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit 2 Mineralization of Organic & Inorganic Matter in Soil Lectures: 8

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit 3 Microbial Activity in Soil and Green House Gases Lectures: 5

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 4 Microbial Control of Soil Borne Plant Pathogens Lectures: 8

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit 5 Biofertilization, Phytostimulation, Bioinsecticides Lectures: 15

Plant growth promoting bateria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Course Outcomes:

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

1. Develop knowledge in Plant growth promoting microbes
2. Acquire knowledge on various plant diseases affecting agricultural crops
3. Understand the pathogenesis, prevention and management.
4. Gain basic knowledge of Airborne transmission of microbes and sampling techniques and water ecosystem.

Reference Books:

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi. 3
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc. 1
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

MCRB6321	Microbes in Sustainable Agriculture and Development lab	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. Study soil profile
2. Study microflora of different types of soils
3. Rhizobium as soil inoculants characteristics and field application
4. Azotobacter as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

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

Semester	Course Code	Course Name	(L-T-P)	Credits
III	MCRB3210	Microbiological Analysis of Air and Water	4-0-0	4

III	MCRB3220	Biofertilizers and Biopesticides	4-0-0	4
IV	MCRB4210	Microbial Diagnosis in Health Clinics	4-0-0	4
IV	MCRB4220	Management of Human Microbial Diseases	4-0-0	4

MCRB3210	**Microbiological Analysis of Air and Water**	**2L:0T:0P**	**2 Credits**

Course Objective:

The objectives of this course are:

1. To impart skills to students in the area of Quality Control. This is essential for food and pharmaceutical industries to ensure that their final products are consistent, safe, effective and predictable.
2. To become familiar with various methodologies for detection of different micro-organisms (qualitative and quantitative methods) and compliance with standards.

Detailed Syllabus

Unit 1 Aeromicrobiology Lectures: 4

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis Lectures: 7

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures Lectures: 4

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology Lectures: 4

Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water Lectures: 7

Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Course Outcomes:

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

1. Knowledge about Good Laboratory Practices and biosafety.
2. Understand of the various tests used in food and pharmaceutical industries to detect and assess microbial load.
3. Learnt the concepts of TQM and will understand the checks that can be performed to manage microbiological issues.
4. Familiar with various standards and certifications for food and pharmaceutical products.

Reference Books:

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory

Manual, CRC Press Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
3. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

MCRB3220	**Biofertilizers and Biopesticides**	**2L:0T:0P**	**2 Credits**

Course Objective:

The objectives of this course are:

1. To develop clear understanding of different types of biofertilizers, their benefits and limitations in their uses over chemical fertilizers.
2. To learn production of different types of biofertilizers at commercial level for the distribution to the end users.
3. To enable the students learn the eco friendly ways to control agricultural pests and pathogens.

Detailed Syllabus:

Unit 1 Biofertilizers Lectures: 10

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, Azolla - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application**.**

Unit 2 Non - Symbiotic Nitrogen Fixers Lectures: 4

Free living Azospirillum, Azotobacter - free isolation, characteristics, mass inoculums, production and field application**.**

Unit 3 Phosphate Solubilizers Lectures: 4

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Unit 4 Mycorrhizal Biofertilizers Lectures: 5

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides Lectures: 7

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications, Viruses – cultivation and field applications.

Course Outcomes:

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

1. Familiar with the commonly used bacterial, fungal and cyanobacterial biofertilizers for different crops.
2. Compare biofertilizers with chemical fertilizers in increasing crop productivity and will become familiar with the isolation, mass culturing and field applications of symbiotic nitrogen fixers.
3. Gain in depth knowledge of isolation, characteristics, and mass production of non symbiotic nitrogen fixers and phosphate-solubilising microorganisms.

4. Understand production and field applications of bacterial, fungal and viral biopesticides in controlling pests population.

Reference Books:

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers. 4
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

MCRB4210	**Microbial Diagnosis in Health Clinics**	**2L:0T:0P**	**2 Credits**

Course Objective:

1. To introduce the students to the importance of diagnosis of pathogens in controlling diseases.
2. To become familiar with various approaches used for diagnosis along with their advantages and limitations. To learn the importance of antimicrobial resistance and methods to determine it are also covered in this course.

Detailed Syllabus:

Unit 1 Importance of Diagnosis of Diseases Lectures: 5

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit 2 Collection of Clinical Samples Lectures: 5

How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit 3 Direct Microscopic Examination and Culture. Lectures: 5

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsastained thin blood film for malaria Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit 4: Serological and Molecular Methods Lectures: 5

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Unit 5: Kits for Rapid Detection of Pathogens Lectures: 5

Typhoid, Dengue and HIV, Swine flu

Unit 6: Testing for Antibiotic Sensitivity in Bacteria Lectures: 5

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

Course Outcomes:

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

1. Understood the importance and challenges in detecting pathogens. Will have a fair understanding of various methods used for collection, transport and storage of clinical samples.
2. Acquainted with the principles of various classical and newer approaches for the identification of microbial pathogens such as microscopy, culturing, biochemical tests, serological and molecular methods.
3. Understand of the applicability of various detection methods in the form of kits for rapid detection of pathogens.
4. Learnt various methods for determination of antimicrobial resistance in bacterial pathogens.

Reference Books:

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

MCRB4220	**Management of Human Microbial Diseases**	**2L:0T:0P**	**2 Credits**

Course Objective:

1. To develop a clear understanding of the wide spectrum of human diseases caused by different micro-organisms
2. To introduce the students to the diverse antibiotics used for therapy, as well as familiarize them with the epidemiological aspects of the disease with respect to transmission and preventive methods.

Detailed Syllabus:

Unit 1 Human Diseases Lectures: 4

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Unit 2 Microbial diseases Lectures: 12

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention**.**

Unit 3 Therapeutics of Microbial diseases Lectures: 8

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides. Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit 4 Prevention of Microbial Diseases Lectures: 6

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Course Outcomes:

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

1. Introduced to the microbial diseases of various organ systems, their causative agents, symptoms as well as modes of transmission. Will have also gained a brief insight into newly emerging microbial diseases, their geographical distribution, factors responsible for their spread, and their control measures.
2. Learn about the mode of action of different anti- microbial agents, concept of antimicrobial resistance, and updates on current therapeutics.
3. Familiarized with the methods of disease prevention and types of immunization methods and vaccines being used currently.

Reference Books:

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

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