DAV UNIVERSITY, JALANDHAR
DEPARTMENT OF MICROBIOLOGY

Course Scheme & Syllabus
For
B.Sc. (Hons.) Microbiology
(Programme ID 6)
1st to 6th Semester
Examinations 2018–2019 Session Onwards

Course Scheme and Syllabus Applicable to Admissions in 2018-2019

Total minimum credits required for B.Sc. (Hons.) Microbiology are 148

Scheme of Courses B.Sc.
B.Sc. Microbiology (Hons.)

Semester 1

S. No	Course Code	Course Title	Type	L	T	P	Cr
1	MIC111	Introduction to Microbiology	Core	4	0	0	4
2	BCH101	Biomolecules	Core	4	0	0	4
3	ENG151B	Basic Communication Skills	AECC	3	0	0	3
4			GE	4	0	0	4
5	MIC112	Introduction to Microbiology Laboratory	Core	0	0	3	2
6	BCH102	Biomolecules Laboratory	Core	0	0	3	2
7			GE	0	0	3	2
8	ENG152A	Basic Communication Skills Laboratory	AECC	0	0	2	1
Total							22
Generic Elective Courses (Choose one Theory and corresponding Laboratory course)							
1	ZOO154	Zoo Diversity	GE	4	0	0	4
2	ZOO155	Zoo Diversity Laboratory	GE	0	0	3	2
3	BOT131	Plant Diversity	GE	4	0	0	4
4	BOT132	Plant Diversity Laboratory	GE	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses
B.Sc. Microbiology (Hons.)

Semester 2

S. No	Course Code	Course Title	Type	L	T	P	Cr
1	MIC113	Bacteriology	Core	4	0	0	4
2	BTY121	Cell Biology	Core	4	0	0	4
3	EVS100	Environmental Studies	AECC	4	0	0	4
4			GE	4	0	0	4
5	SGS107	General Knowledge and Human Values	AECC	4	0	0	4
6	MIC114	Bacteriology Laboratory	Core	0	0	3	2
7	BTY122	Cell Biology Laboratory	Core	0	0	3	2
8			GE	0	0	3	2
Total							26
Generic Elective Courses (Choose one Theory and corresponding Laboratory course)							
1	CHE157	General Chemistry – I	GE	4	0	0	4
2	CHE158	General Chemistry – I Laboratory	GE	0	0	3	2
3	PHY153	Optics and Lasers	GE	4	0	0	4
4	PHY154	Optics Laboratory	GE	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses B.Sc.
B.Sc. Microbiology (Hons.)

Semester 3

S. No	Course Code	Course Title	Type	L	T	P	Cr
1	BTY393	Virology	Core	4	0	0	4
2	MIC221	Microbial Physiology	Core	4	0	0	4
3	MIC331	Medical Microbiology	Core	4	0	0	4
4			SEC	2	0	0	2
5			GE	4	0	0	4
6	BTY394	Virology Laboratory	Core	0	0	3	2
7	MIC222	Microbial Physiology Laboratory	Core	0	0	3	2
8	MIC332	Medical Microbiology Laboratory	Core	0	0	3	2
9			GE	0	0	3	2
Total							26
Generic Elective Courses (Choose one Theory and corresponding Laboratory course)							
1	BOT131	Plant Diversity	GE	4	0	0	4
2	BOT132	Plant Diversity Laboratory	GE	0	0	3	2
3	BOT241	Plant Physiology and Metabolism	GE	4	0	0	4
4	BOT242	Plant Physiology Metabolism Laboratory	GE	0	0	3	2
Skill Enhancement Elective Courses (Choose one Theory course)							
1	MIC266	Microbiological Analysis of Air and Water	SEC	2	0	0	2
2	MIC262	Microbial Diagnosis in Health Clinics	SEC	2	0	0	2

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses B.Sc.
B.Sc. Microbiology (Hons.)

Semester 4

S. No	Course Code	Course Title	Type	L	T	P	Cr
1	MIC225	Microbial Genetics	Core	4	0	0	4
2	BTY241	Molecular Biology	Core	4	0	0	4
3	MIC227	Food and Dairy Microbiology	Core	4	0	0	4
4			GE	4	0	0	4
5			SEC	2	0	0	2
6	MIC226	Microbial Genetics Laboratory	Core	0	0	3	2
7	BTY242	Molecular Biology Laboratory	Core	0	0	3	2
8	MIC228	Food and Dairy Microbiology Laboratory	Core	0	0	3	2
9			GE	0	0	3	2
Total							26
Generic Elective Courses (Choose one Theory and corresponding Laboratory course)							
1	CHE257	General Chemistry – II	GE	4	0	0	4
2	CHE258	General Chemistry – II Laboratory	GE	0	0	3	2
3	BTY243	Biotechnology and Human Welfare	GE	4	0	0	4
4	BTY244	Biotechnology and Human Welfare Laboratory	GE	0	0	3	2
Skill Enhancement Elective Courses (Choose one Theory course)							
1	MIC261	Management of Human Microbial Diseases	SEC	2	0	0	2
2	MIC264	Food Fermentation Techniques	SEC	2	0	0	2

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses
B.Sc. Microbiology (Hons.)

Semester 5

S. No	Course Code	Course Title	Type	L	T	P	Cr
1	MIC223	Environmental Microbiology	Core	4	0	0	4
2	MIC353	Soil Microbiology	Core	4	0	0	4
3			DSE	4	0	0	4
4			DSE	4	0	0	4
5	MIC354	Soil Microbiology Laboratory	Core	0	0	3	2
6	MIC224	Environmental Microbiology Laboratory	Core	0	0	3	2
7			DSE	0	0	3	2
8			DSE	0	0	3	2
Total							24
Discipline Specific Elective (Choose two Theory and corresponding Laboratory course)							
1	BTY231	Genetics	DSE	4	0	0	4
2	BTY232	Genetics Laboratory	DSE	0	0	3	2
3	MIC345	Microbial Biotechnology	DSE	4	0	0	4
4	MIC346	Microbial Biotechnology Laboratory	DSE	0	0	3	2
5	BTY353	Recombinant DNA Technology	DSE	4	0	0	4
6	BTY354	Recombinant DNA Technology Laboratory	DSE	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme of Courses
B.Sc. Microbiology (Hons.)

Semester 6

S. No	Course Code	Course Title	Type	L	T	P	Cr
1	MIC333	Immunology	Core	4	0	0	4
2	MIC335	Industrial Microbiology	Core	4	0	0	4
3			DSE	4	0	0	4
4			DSE	4	0	0	4
5	MIC334	Immunology Laboratory	Core	0	0	3	2
6	MIC336	Industrial Microbiology Laboratory	Core	0	0	3	2
7			DSE	0	0	3	2
8			DSE	0	0	3	2
Total							24
Discipline Specific Elective (Choose two Theory and corresponding Laboratory course)							
1	BTY361	Bioanalytical Tools	DSE	4	0	0	4
2	BTY362	Bioanalytical Tools Laboratory	DSE	0	0	3	2
3	MIC355	Biosafety and IPR	DSE	4	0	0	4
4	MIC356	Biosafety and IPR Laboratory	DSE	0	0	3	2
5	MIC347	Plant Pathology	DSE	4	0	0	4
6	MIC348	Plant Pathology Laboratory	DSE	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

CORE COURSES

Course Code: MIC111

Course Title: INTRODUCTION TO MICROBIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective:
The objective of this course is to provide an overview of the discipline of microbiology to the students in order to make them understand the scope of microbiology.

Course Content:

Unit 1 History of Development of Microbiology **No. of Hours: 15**
Development of microbiology as a discipline. Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming
Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman
Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microbial World **No. of Hours: 40**
A. Systems of classification
Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three domain classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms
B. General characteristics of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.
• **Algae**
History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.
• **Fungi**
Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.
Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.
• **Protozoa**
General characteristics with special reference to *Amoeba*, *Paramecium*, *Plasmodium*, *Leishmania and Giardia*

Unit 3 An overview of Scope of Microbiology **No. of Hours: 5**

SUGGESTED READINGS

1. Tortora GJ, Funke BR and Case CL. *Microbiology: An Introduction*. 9th edition. Pearson Education. 2008. Print

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. *Brock Biology of Microorganisms*. 14th edition. Pearson International Edition. 2014. Print

3. Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print

4.Wiley JM, Sherwood LM and Woolverton CJ. *Prescott's Microbiology*. 9th Edition. McGraw Hill International. 2013. Print

5. Atlas RM. *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers. 1997. Print

6. Pelczar MJ, Chan ECS and Krieg NR. *Microbiology*. 5th edition. McGraw Hill Book Company. 1993. Print

7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. *General Microbiology*. 5th edition. McMillan. 2005. Print

Course Code: MIC112

Course Title: INTRODUCTION TO MICROBIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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*

Course Code: BCH101

L	T	P	Credit
4	0	0	4

Course Title: BIOMOLECULES

Unit 1 **(15 hours)**

Introduction to Biochemistry

Water as a biological solvent. Weak acids and bases. pH and buffers. Henderson-Hasselbalch equation. Physiological buffers. Fitness of the aqueous environment for living organisms.

Carbohydrates

Structure of monosaccharides. Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides. Glycoproteins.

Unit 2 **(15 hours)**

Proteins

Introduction to proteins. Classification based on solubility, shape, composition and functions. Amino acids: common structural features, stereoisomerism and RS system of designating optical isomers. Classification and structures of standard amino acids as zwitterion in aqueous solutions. Physical and chemical properties of amino acids. Titration of amino acids. Separation of amino acids. Essential amino acids.

Structure of peptide bond. Solid-phase synthesis of peptides. Peptide sequencing. Chemical and enzymatic cleavage of polypeptide chains and separation of peptides. Levels of structure in protein architecture. denaturation and renaturation of proteins. Behaviour of proteins in solutions. Salting in and salting out of proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins.

Unit 3 **(15 hours)**

Nucleic Acids

Nature of genetic material. Evidence that DNA is the genetic material. Composition of DNA and RNA. Generalized structural plan and Nomenclature of nucleic acids. DNA double helix. Structure and roles of different types of RNA. Size of DNA in prokaryotes and eukaryotes. Central dogma of molecular biology. Concepts of gene, genome and chromosome.

Porphyrins

Porphyrin nucleus and classification of porphyrins. Important metalloporphyrins occurring in nature. Detection of porphyrins. Bile pigments – chemical nature and physiological significance.

Unit 4 **(15 hours)**

Lipids

Definition and classification of lipids. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids, prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats – hydrolysis, saponification value, rancidity of fats, Reichert-Meissel Number and reaction of glycerol. Biological significance of fats. Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens), sphingomyelins, glycolipids – cerebrosides, gangliosides. Properties and functions of phospholipids, isoprenoids and sterols.

Recommended books:

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition, W.H. Freeman & Company, New York, 2008. Print.
2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.
3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

Course Code: BCH102

L	T	P	Credit
0	0	3	2

COURSE TITLE: BIOMOLECULES LABORATORY

Experiments:

1. Preparation of normal, molar and percent solutions.
2. Titration curve of Glycine.
3. Buffer preparation.
4. Qualitative tests for Carbohydrates, Lipids, Amino acids, Proteins, Nucleic acids
5. Preparation of casein from milk and determination of its isoelectric point.
6. Titrimetric analysis of Vitamin C.

Course Code: MIC113

Course Title: BACTERIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective:
This course will allow the student to develop an understanding about bacteria, including their structural organization, reproduction and classification. This course will also expose the students to the commonly used techniques in the field of bacteriology.

Course Content:

Unit 1 Cell organization No. of Hours: 14
Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.
Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.
Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.
Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids
Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological techniques No. of Hours: 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 3 Microscopy No. of Hours: 6
Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 4 Growth and nutrition No. of Hours: 8
Nutritional requirements in bacteria and nutritional categories;
Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media, Diauxic growth, Synchronous growth
Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation
Chemical methods of microbial control: disinfectants, types and mode of action

Unit 5 Reproduction in Bacteria No. of Hours: 3
Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 6 Bacterial Systematics No. of Hours: 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 7 Important archaeal and eubacterial groups **No. of Hours: 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

SUGGESTED READINGS

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

Course Code: MIC114

Course Title: BACTERIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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.

Course Code: BTY121

Course Title: CELL BIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: To study in detail about the cell which encompasses the cell structure, structure and functions of organelles, locomotion, life cycle and division. To impart knowledge to students about the basics of stem cells and their applications as well as to introduce them to the world of cellular differentiation and cloning.

Course Content:

Unit I: Cells and organelles (18 lectures)

Introduction: Cell as a basic unit of living system, Biochemical composition of cell, the cell theory, ultra structure of cell.

Cytoskeleton: The Nature of the Cytoskeleton and endomembrane system, intermediate filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins.

Cell membranes: Architecture and dynamics (models); Membrane composition, the lipid bilayer/membrane; A summary of membrane functions - simple diffusion, Facilitated transports, Active transport.

Unit II: Eukaryotic cell organelles and functions (16 lectures)

Structure and functions of the following cell organelles: endoplasmic reticulum, Golgi complex, lysosome, ribosome and mitochondria. Principles & applications of differential centrifugation in the fractionation of cellular organelles and Svedberg unit; endosymbiotic theories

Unit III: Nucleus and Cell Cycle (10 lectures)

Genome organization, structure and function of nucleus, nuclear envelope, structure of chromatin, nucleosome and chromosome, cell cycle, mitosis and meiosis.

Unit IV: Molecule and Protein Trafficking (16 lectures)

The compartmentalization of higher cells, transport of molecules into and out of organelle membranes, the endoplasmic reticulum, transport from the ER through the Golgi Apparatus, transport from the trans Golgi network to lysosomes, transport from the plasma membrane via endosome: Endocytosis, molecular mechanisms of vesicular transport; introduction to transit peptide, signal peptide and translocons.

Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5th Edition. Garland Science. 2007. Print.

2. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print.

3. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. *The World of the Cell.* 7th Edition. Benjamin Cummings. 2008. Print.

4. Powar, C.B. *Cell Biology*. Himalaya Publishing House. 2007. Print.

5. G Karp. Cell and molecular Biology. John wiley and sons 6th edition.

6. Cooper G.M. The *Cell .6th* edition

Course Code: BTY122

Course Title: CELL BIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Understanding principle, working and handling of light microscope and microtome.

2. Understanding microscope adjustments, light sources, microscopic measurements, calibration and types of microscopes available.

3. Observation of microorganisms under phase contrast microscope and dark-field microscope.

4. Preparation of different types of stains

5. Cytological preparations, Fixation, dehydration and staining

6. Squash preparation of meiotic and mitotic cells

7. Embedding and sectioning.

8. Examination of various stages of mitosis and meiosis

Course Code: BTY393

Course Title: VIROLOGY

L	T	P	Credit
4	0	0	4

Course Objective: To give an introduction to the basics in virology. General information on morphology, architecture, transmission of plant and animal viruses and viruses infecting microbes and insects.

Course Content:

Unit-I **(15 hours)**

Introduction & History of Virology, Origin & Evolution of Viruses, Taxonomy. Defective Particles, Multiparticles, Viroids, Virusoids, Prions, Mycoviruses, Bacteriophage, Cynophage, Virophage, Baculoviruses.

Unit-II **(15 hours)**

Morphology, Architecture and methods for its study, Host range, Transmission, Movement, Symptomatology, Serology, methods for assay, detection and diagnosis, Virus purification.

Unit-III **(15 hours)**

Biochemistry of Viruses & Viral Pathogenesis, Organization & Expression of Viral genomes. Replication of RNA and DNA Viruses.

Unit-IV **(15 hours)**

Management and control of viruses including development of virus disease resistant transgenics.

Reference Books:

1. Hull, R. *Matthews Plant Virology.* 4th Edition. Academic Press. 2001. Print.

2. Knipe, D.M. and Howley, P.M. *Fields Virology*. 5th Edition. Lippincott Williams & Wilkins. 2006. Print.

3. Cann, A.J. *Principles of Molecular Virology*. 5th Edition. Academic Press. 2011. Print.

4. Carter, J. and Saunders, V. *Virology: Principles and Applications.* 2nd Edition. John Wiley & Sons Ltd. 2013. Print.

Course Code: BTY394

Course Title: VIROLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Virus diagnosis using ELISA
2. Virus diagnosis using PCR
3. Virus diagnosis using slot-blot hybridization
4. Study of symptoms of virus diseases through visit to local diseases fields and/or photographs
5. Collection and Processing of Viral Samples
6. Effect of virus infection on chloroplast number and cell size
7. Transmission of plant viruses
8. Collection and Identification of local insect vectors
9. Determination of disease progress curve

Course Code: MIC221

Course Title: MICROBIAL PHYSIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective:

This course will introduce the students to the diversity of microbial life-styles including heterotrophy, chemolithotrophy, photolithotrophy, fermentation, aerobic and anaerobic respiration. The students will also come to know carbon and nitrogen nutrition in microbes.

Course Content:

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth

No. of Hours: 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 **No. of Hours: 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 **No. of Hours: 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

No. of Hours: 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 **No. of Hours: 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, Autotrophy in photosynthetic bacteria

Unit 6 Nitrogen Metabolism - an overview **No. of Hours: 6**

Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction,denitrification

SUGGESTED READINGS

1. Madigan MT, and Martinko JM. *Brock Biology of Microorganisms*. 14th edition. Prentice Hall International Inc. 2014. Print

2. Moat AG and Foster JW. *Microbial Physiology*. 4th edition. John Wiley & Sons. 2002. Print
3. Reddy SR and Reddy SM. *Microbial Physiology*. Scientific Publishers India. 2005. Print
4. Gottschalk G. *Bacterial Metabolism*. 2nd edition. Springer Verlag. 1986. Print
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. *General Microbiology*. 5th edition, McMillan Press. 1987. Print
7. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education. 2013. Print

Course Code: MIC222

Course Title: MICROBIAL PHYSIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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.*
9. Determination of thermal death point of the given culture.

Course Code: MIC223

Course Title: ENVIRONMENTAL MICROBIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The students will come to know about the various habitats occupied by the microbes, their adaptations, their interactions with each other and higher organisms. The students will also be exposed to the role of microbes in the environment, waste management etc.

Course Content:

Unit 1 Microorganisms and their Habitats **No. of Hours: 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 **No. of Hours: 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 **No. of Hours: 14**

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 **No. of Hours: 14**

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 **No. of Hours: 6**

Bioremediation: basic concepts, in situ bioremediation, ex-situ bioremediation, Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

Unit 6 Microbial Mineral Recovery

Bioleaching and biomining- Introduction and advantages, methods of microbial mineral recovery-heap method, continuous method, recovery of copper, recovery of uranium

SUGGESTED READINGS

1. Atlas RM and Bartha R. *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print
2. Madigan MT, Martinko JM and Parker J. *Brock Biology of Microorganisms*. 14th edition. Pearson/ Benjamin Cummings. 2014. Print
3. Maier RM, Pepper IL and Gerba CP. *Environmental Microbiology*. 2nd edition, Academic Press. 2009. Print
4. Okafor, N. *Environmental Microbiology of Aquatic & Waste systems*. 1st edition, Springer, New York. 2011. Print
5. Singh A, Kuhad, RC & Ward OP. *Advances in Applied Bioremediation*. Volume 17, Springer-Verlag, Berlin Hedeilberg. 2009. Print
6. Barton LL & Northup DE. *Microbial Ecology*. 1st edition, Wiley Blackwell, USA. 2011. Print
7. Coyne MS. *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning. 2001. Print
8. Lynch JM & Hobbie JE. *Microorganisms in Action: Concepts & Application in Microbial Ecology*. Blackwell Scientific Publication, U.K. 1988. Print
9. Martin A. *An Introduction to Soil Microbiology*. 2nd edition. John Wiley & Sons Inc. New York & London. 1977. Print
10. Stolp H. *Microbial Ecology: Organisms Habitats Activities*. Cambridge University Press, Cambridge, England. 1988. Print
11. Subba Rao NS. *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi. 1999. Print
12. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education. 2013. Print

Course Code: MIC224

Course Title: ENVIRONMENTAL MICROBIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
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. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

Course Code: MIC225

Course Title: MICROBIAL GENETICS

L	T	P	Credit
4	0	0	4

Course Objective: This course will introduce the students to various aspects of microbial genetics including genome organization in bacteria and phages, plasmids, genetic recombination and transposition in bacteria.

Course Content:

Unit 1 Genome Organization and Mutations **No. of Hours: 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, Genome organization of *Aspergillus nidulans*

Unit 2 Plasmids **No. of Hours: 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 **No. of Hours: 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, Recombination and genome mapping in viruses

Unit 4 Phage Genetics **No. of Hours: 8**

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

Unit 5 Transposable elements **No. of Hours: 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.

SUGGESTED READINGS

1. Klug WS, Cummings MR, Spencer, C, Palladino, M. *Concepts of Genetics*, 10th Ed., Benjamin Cummings. 2011. Print

2. Krebs J, Goldstein E, Kilpatrick S. *Lewin's Essential Genes*, 3rd Ed., Jones and Bartlett Learning. 2013. Print

3. Pierce BA. *Genetics: A Conceptual Approach*, 4th Ed., Macmillan Higher Education Learning. 2011. Print

4. Watson JD, Baker TA, Bell SP et al. *Molecular Biology of the Gene*, 6th Ed., Benjamin Cummings. 2008. Print

5. Gardner EJ, Simmons MJ, Snustad DP. *Principles of Genetics*. 8th Ed. Wiley-India. 2008. Print

6. Russell PJ. *i Genetics- A Molecular Approach*. 3rd Ed, Benjamin Cummings. 2009. Print

7. Sambrook J and Russell DW. *Molecular Cloning: A Laboratory Manual*. 4th Edition, Cold Spring Harbour Laboratory press. 2001. Print

8. Maloy SR, Cronan JE and Friefelder D. *Microbial Genetics*. 2nd Ed., Jones and Barlett Publishers. 2004. Print

Course Code: MIC226

Course Title: MICROBIAL GENETICS LABORATORY

L	T	P	Credit
0	0	3	2

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

Course Code: MIC227

Course Title: FOOD AND DAIRY MICROBIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The students will come to know about the basic principles of food spoilage and food preservation and food borne diseases. This course will also allow the students understand some significant food fermentations.

Course Content:

Unit 1 Foods as a substrate for microorganisms No. of Hours: 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 No. of Hours: 10

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

Unit 3 Principles and methods of food preservation No. of Hours: 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, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins, Concept of modified atmospheric packaging

Unit 4 Fermented foods No. of Hours: 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) No. of Hours: 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*

Unit 6 Food sanitation and control No. of Hours: 5

HACCP, Indices of food sanitary quality and sanitizers

Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. No. of Hours: 5

SUGGESTED READINGS

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

2. Banwart JM. *Basic Food Microbiology*. 1st edition. CBS Publishers and Distributors, Delhi, India. 1987. Print

3. Davidson PM and Brannen AL. *Antimicrobials in Foods*. Marcel Dekker, New York. 1993. Print

4. Dillion VM and Board RG. *Natural Antimicrobial Systems and Food Preservation*. CAB International, Wallingford, Oxon. 1996. Print

5. Frazier WC and Westhoff DC. *Food Microbiology*. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India. 1992. Print

6. Gould GW. *New Methods of Food Preservation*. Blackie Academic and Professional, London. 1995. Print

7. Jay JM, Loessner MJ and Golden DA. *Modern Food Microbiology*. 7th edition, CBS Publishers and Distributors, Delhi, India. 2005. Print

8. Lund BM, Baird Parker AC, and Gould GW. *The Microbiological Safety and Quality of Foods*. Vol. 1-2, ASPEN Publication, Gaithersberg, MD. 2000. Print

9. Tortora GJ, Funke BR, and Case CL. *Microbiology: An Introduction*. 9th edition. Pearson Education. 2008. Print

Course Code: MIC228

Course Title: FOOD AND DAIRY MICROBIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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.

Course Code: BTY241

Course Title: MOLECULAR BIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The aim is to extend understanding of the molecular mechanisms via which genetic information is stored, expressed and transmitted among generations.

Course Content:

UNIT I: DNA structure and replication (15 hours)

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II: DNA damage, repair and homologous recombination (15 hours)

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.

UNIT III: Transcription and RNA processing (15 hours)

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' capping, polyadenylation, splicing of mRNA, rRNA and tRNA.

UNIT IV: Regulation of gene expression and translation (15 hours)

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins.

Reference Books:

1. Atala, A. and Lanza, R. *Methods of Tissue Engineering*. 1st Edition. Academic Press. 2001. Print.

2.Harrison, M.A. and Rae, I.F. *General Techniques of Cell Culture*. 1st Edition. Cambridge University Press. 1997. Print.

3. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3rd Edition. Oxford University Press. 2000. Print.

4. Friefelder, D. *Molecular Biology*. 2nd Edition. Narosa Book Distributors Pvt. Ltd. 2008. Print.

5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5th Edition. Garland Science. 2007. Print.

Course Code: BTY242

Course Title: MOLECULAR BIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Isolation of DNA from animal and plant tissue using classical methods
2. Isolation of RNA from animal and plant tissue using classical methods
3. Isolation of plasmid DNA from *E. coli* using boiling-prep and alkali lysis method
4. Restriction fragment length polymorphism
5. Agarose gel electrophoresis
6. Polyacrylamide gel electrophoresis
7. Elution of nucleic acids from agarose gel
8. Primer Designing
9. Polymerase Chain Reaction

Course Code: BTY353

Course Title: RECOMBINANT DNA TECHNOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: Recombinant DNA technology refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics. The students will learn how the genes can be cut and pasted from one organism to another and what its implications are.

Course Content:

UNIT I **(15 hours)**

Molecular tools and applications - restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR

UNIT II **(15 hours)**

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription, Genome mapping, DNA fingerprinting, Applications of Genetic Engineering; Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

UNIT III **(15 hours)**

Random and site-directed mutagenesis: PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV **(15 hours)**

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Reference Books:

1. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. *Recombinant DNA: Genes and Genomes.* 3rd Edition. W.H. Freeman & Company. 2006. Print.

2. Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation & Genomics.*7th Edition. Oxford University Press. 2006. Print.

3. Lodge, J., Lund, P. and Minchin, S. *Gene Cloning: Principles and Applications*. 1st Edition. Taylor & Francis. 2006. Print.

5. Brown,T.A. *Gene cloning and DNA analysis: An introduction*.5thEdition. Wiley-Blackwell. 2010. Print.

6. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III.2nd Edition. Cold Spring Harbor Laboratory,1989. Print.

Course Code: BTY354

Course Title: RECOMBINANT DNA TECHNOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E. coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

Course Code: MIC331

Course Title: MEDICAL MICROBIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The objective of this course is to provide an overview about the significance of medical microbiology including some common diseases caused by bacteria, viruses, protozoa and fungi as well as basic aspects of clinical microbiology and anti-microbial agents.

Course Content:

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

No. of Hours: 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 **No. of Hours: 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 **No. of Hours: 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 **No. of Hours: 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 diseases **No. of Hours: 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

Unit 6 Fungal diseases **No. of Hours: 5**

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

Unit 7 Antimicrobial agents: General characteristics and mode of action

No. of Hours: 8

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism

Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin

Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine
Antibiotic resistance, MDR, XDR, MRSA, NDM-1

SUGGESTED READINGS

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

Course Code: MIC332

Course Title: MEDICAL MICROBIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Identify bacteria (any three of *E. coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, *Bacillus*) usinglaboratory 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.

Course Code: MIC333

Course Title: IMMUNOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The course will expose the students to the basic concepts of immune system including important cells and organs on immune system, antigens and antibodies, generation of immune response, immunological techniques etc.

Course Content:

Unit 1 Introduction **No. of Hours: 4**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Unit 2 Immune Cells and Organs **No. of Hours: 7**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Unit 3 Antigens **No. of Hours: 4**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Unit 4 Antibodies **No. of Hours: 6**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Unit 5 Major Histocompatibility Complex **No. of Hours: 5**

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Unit 6 Complement System **No. of Hours: 4**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response **No. of Hours: 10**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit 8 Immunological Disorders and Tumor Immunity **No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit 9 Immunological Techniques **No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. *Cellular and Molecular Immunology*. 6th edition Saunders Publication, Philadelphia. 2007. Print

2. Delves P, Martin S, Burton D, Roitt IM. *Roitt's Essential Immunology*. 11th edition Wiley-Blackwell Scientific Publication, Oxford. 2006. Print

3. Goldsby RA, Kindt TJ, Osborne BA. *Kuby's Immunology*. 6th edition W.H. Freeman and Company, New York. 2007. Print
4. Murphy K, Travers P, Walport M. *Janeway's Immunobiology*. 7th edition Garland Science Publishers, New York. 2008. Print
5. Peakman M, and Vergani D. *Basic and Clinical Immunology*. 2nd edition Churchill Livingstone Publishers, Edinberg. 2009. Print

Course Code: MIC334

Course Title: IMMUNOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immunoelectrophoresis.

Course Code: MIC335

Course Title: INDUSTRIAL MICROBIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The objective of this course is to provide knowledge to the students about the fundamentals of industrial microbiology and fermentation technology like isolation of industrially important microbes, types of fermenters, downstream processing etc.

Course Content:

Unit 1 Introduction to industrial microbiology **No. of Hours: 2**

Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media **No. of Hours: 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 **No. of Hours: 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 **No. of Hours: 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) **No. of Hours: 18**

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12

Enzymes (amylase, protease, lipase, xylanases, cellulases)

Wine, beer, Bread

Unit 6 Enzyme immobilization **No. of Hours: 4**

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

SUGGESTED READINGS

1. Patel A.H. *Industrial Microbiology*. 1st edition, Macmillan India Limited. 1996. Print

2. Okafor N. *Modern Industrial Microbiology and Biotechnology*. 1st edition. Bios Scientific Publishers Limited. USA 2007. Print

3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. *Industrial Microbiology: An Introduction.* 1st edition. Wiley – Blackwell. 2001. Print

4. Glaze A.N. and Nikaido H. *Microbial Biotechnology: Fundamentals of Applied Microbiology*. 1st edition. W.H. Freeman and Company. 1995. Print

5. Casida LE. *Industrial Microbiology*. 1st edition. Wiley Eastern Limited. 1991. Print

6. Crueger W and Crueger A. *Biotechnology: A textbook of Industrial Microbiology*. 2nd edition. Panima Publishing Co. New Delhi. 2000. Print

7. Stanbury PF, Whitaker A and Hall SJ. *Principles of Fermentation Technology*. 2nd edition, Elsevier Science Ltd. 2006. Print

Course Code: MIC336

Course Title: INDUSTRIAL MICROBIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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.

DISCIPLINE SPECIFIC ELECTIVES

Course Code: MIC353

Course Title: SOIL MICROBIOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The aim of this course is to provide an insight into the role and significance of microbes in soil including their role as mineralizing agents, biocontrol agents, biofertilizers. This course will also introduce the students to the utilization of genetically modified crops and their significance.

Course Content:

Unit 1 Soil Microbiology **No of Hours: 8**
History of Soil Microbiology, Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil, Soil microbial biomass, Soil enzymes and their functions

Unit 2 Mineralization of Organic & Inorganic Matter in Soil **No of Hours: 8**
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit 3 Microbial Activity in Soil and Green House Gases **No of Hours: 5**
Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 4 Microbial Control of Soil Borne Plant Pathogens **No of Hours: 8**
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit 5 Biofertilization, Phytostimulation, Bioinsecticides **No of Hours: 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

Unit 6 Secondary Agriculture Biotechnology **No of Hours: 10**
Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Unit 7 GM crops **No of Hours: 6**
Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

SUGGESTED READINGS

1. Agrios GN. *Plant Pathology*. 5th edition. Academic press, San Diego. 2006. Print
2. Singh RS. *Plant Diseases Management*. 7th edition. Oxford & IBH, New Delhi. 1998. Print
3. Glick BR, Pasternak JJ, and Patten CL. *Molecular Biotechnology*. 4th edition, ASM Press. 2010. Print
4. Atlas RM and Bartha R. *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print
5. Maier RM, Pepper IL and Gerba CP. *Environmental Microbiology*. 2nd edition, Academic Press. 2009. Print
6. Barton LL and Northup DE. *Microbial Ecology*. 1st edition, Wiley Blackwell, USA. 2011. Print
7. Campbell RE. *Microbial Ecology*. Blackwell Scientific Publication, Oxford, England. 1983. Print
8. Coyne MS. *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning. 2001. Print
9. Altman A. *Agriculture Biotechnology*, 1st edition, Marcel decker Inc. 1998. Print
10. Mahendra K. Rai. *Hand Book of Microbial Biofertilizers*. The Haworth Press, Inc. New York. 2005. Print

11. Reddy, S.M. et. al. *Bioinoculants for Sustainable Agriculture and Forestry*. Scientific Publishers. 2002. Print
12. Saleem F and Shakoori AR. *Development of Bioinsecticide.* Lap Lambert Academic Publishing GmbH KG. 2012. Print

Course Code: MIC354

Course Title: SOIL MICROBIOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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
7. Isolation of P-solubilizing microorganisms from soil by using PVK agar medium
8. Isolation of siderophore producing microorganisms from soil by using CAS medium
9. Isolation of antifungal bacteria by using agar well diffusion method

Course Code: MIC345

Course Title: MICROBIAL BIOTECHNOLOGY

L	T	P	Credit
4	0	0	4

Course Objective: The objective of this course is to expose the students to the various possible applications of the microbes in the field of medicine, environment and production of various industrially important products.

Course Content:

Unit 1 Microbial Biotechnology and its Applications **No. of Hours: 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 **No. of Hours: 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, Single cell protein

Unit 3 Applications of Microbes in Biotransformations **No. of Hours: 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 **No. of Hours: 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 **No. of Hours: 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, removal of heavy metals from aqueous effluents, Biohydrogen production

Unit 6 RNAi **No. of Hours: 6**

RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions

Unit 7 Intellectual Property Rights **No. of Hours: 4**

Patents, Procedure of Patenting in India, Patenting in biotechnology, Copyrights, Trademarks

SUGGESTED READINGS

1. Ratledge, C and Kristiansen, B. *Basic Biotechnology*. 2nd Edition, Cambridge University Press. 2001. Print

2. Demain, A. L and Davies, J. E. *Manual of Industrial Microbiology and Biotechnology*. 2nd Edition, ASM Press. 1999. Print

3. Swartz, J. R. *Advances in Escherichia coli production of therapeutic proteins*. Current Opinion in Biotechnology, 12, 195–201. 2001. Print

4. Willey JM, Sherwood LM, Woolverton CJ. *Prescott, Harley and Klein's Microbiology*. 9th edition, Mc Graw Hill Publishers. 2014. Print

5. Gupta PK. *Elements of Biotechnology*. 2nd edition, Rastogi Publications. 2009. Print

6. Glazer AN and Nikaido H. *Microbial Biotechnology.* 2nd edition, Cambridge University Press. 2007. Print

7. Glick BR, Pasternak JJ, and Patten CL. *Molecular Biotechnology*. 4th edition, ASM Press. 2010. Print

8. Stanbury PF, Whitaker A, Hall SJ. *Principles of Fermentation Technology*. 2nd edition.,Elsevier Science. 1995. Print

Course Code: MIC346

Course Title: MICROBIAL BIOTECHNOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

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
6. Isolation of cellulolytic microbes from soil sample

Course Code: MIC351

Course Title: BIOSAFETY AND IPR

L	T	P	Credit
4	0	0	4

Course Objective:

Course Content:

Unit 1 No of Hours: 8
Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms
Unit 2 No of Hours: 12
Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.
Unit 3 No of Hours: 4
AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.
Unit 4 No of Hours: 12
Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications-importance of IPR –patentable and non patentables – patenting life – legal protection of biotechnological inventions –world intellectual property rights organization (WIPO).
Unit 5 No of Hours: 12
Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.
Unit 6 No of Hours: 12
Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

SUGGESTED READINGS
1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New
Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution
Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations,
Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology
Management. Jasen Publications, Tiruchirappalli, India.

Course Code: MIC344

Course Title: BIOSAFETY AND IPR LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Study of components and design of a BSL-III laboratory
2. Filing applications for approval from biosafety committee
3. Filing primary applications for patents
4. Study of steps of a patenting process
5. A case study

Course Code: MIC347

L	T	P	Credit
4	0	0	4

Course Title: PLANT PATHOLOGY

Course Objective: The students will come to know about the basic aspects of plant disease development, control of plant diseases and some significant diseases of plants caused by fungi, bacteria and viruses.

Course Content:

Unit 1 Introduction and History of plant pathology **No. of Hours: 5**

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Unit 2 Stages in development of a disease **No. of Hours: 2**

Infection, invasion, colonization, dissemination of pathogens and perennation.

Unit 3 Plant disease epidemiology **No. of Hours: 5**

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit 4 Host Pathogen Interaction **No. of Hours: 19**

A. *Microbial Pathogenicity*

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development.

Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

B. *Genetics of Plant Diseases*

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.

C. *Defense Mechanisms in Plants*

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Unit 5 Control of Plant Diseases **No. of Hours: 10**

Principles & practices involved in the management of plant diseases by different methods, *viz.*

Regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material

Cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches

Chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.

Biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants

Genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit 6 Specific Plant diseases **No. of Hours: 19**

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control

A. Important diseases caused by fungi

White rust of crucifers - *Albugo candida*

Downy mildew of onion - *Peronospora destructor*
Late blight of potato - *Phytophthora infestans*
Powdery mildew of wheat - *Erysiphe graminis*
Ergot of rye - *Claviceps purpurea*
Black stem rust of wheat - *Puccinia graminis tritici*
Loose smut of wheat - *Ustilago nuda*
Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici*
Red rot of sugarcane - *Colletotrichum falcatum*
Early blight of potato - *Alternaria solani*
B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus
C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn
D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro
E. Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadang

SUGGESTED READINGS

1. Agrios GN. *Plant Pathology*. 5th edition. Academic press, San Diego. 2006. Print
2. Lucas JA. *Plant Pathology and Plant Pathogens*. 3rd edition. Blackwell Science, Oxford. 1998. Print
3. Mehrotra RS. *Plant Pathology*. Tata McGraw-Hill Limited. 1994. Print
4. Rangaswami G. *Diseases of Crop Plants in India*. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi. 2005. Print
5. Singh RS. *Plant Diseases Management*. 7th edition. Oxford & IBH, New Delhi. 1998. Print

Course Code: MIC348

Course Title: PLANT PATHOLOGY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

Course Code: BTY231

Course Title: GENETICS

L	T	P	Credit
4	0	0	4

Course Objective:
This course is aimed at understanding the basic concepts of genetics at molecular level to develop analytical and quantitative skills from classical to molecular genetics.

Course Content:

Unit I: Chromosome Theory of Inheritance (6 lectures)
The chromosome theory of heredity, Sex chromosomes, Sex linkage, the parallel behaviour of autosomal genes and chromosomes.

Unit II: Mendelian Genetics (15 lectures)
Mendelian laws of inheritance, Monohybrid cross and the law of segregation, Dihybrid cross and law of independent assortment, Chromosome theory of inheritance, Multiple allele, lethal allele, Blood group, Rh factor, Gene interactions, Modified dihybrid ratio. Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Three point testcross, Interference, Calculating recombinant frequencies from selfed dihybrids, examples of linkage maps, The X2 test mitotic segregation in humans.

Unit III: Fine Structure of Genes and Chromosomes (14 lectures)
The concept of promoter, Coding sequence, Terminator, Induction of gene for expression. Structural organisation of chromatids, Centromeres, Telomeres, Chromatin, Nucleosome organisation; Euchromatin and heterochromatin; Special chromosomes (e.g., polytene and lampbrush chormosomes), Banding patterns in human chromosomes. Structural and numerical aberrations involving chromosomes; Hereditary defects - Kleinefelter, Turner, Cri-du-Chat and Down syndromes. Mutations - spontaneous and induced, Chemical and physical mutagens.

Unit IV: Extrachromosomal inheritance and Molecular Genetics (10 lectures)
Coiling of shell in snails, Mitochondrial and chloroplast genetic systems, population genetics: Hardy-Weinberg equilibrium, Gene and genotypic frequencies.

Reference Books:

1. Strickberger, M.W. *Genetics*. 3rd Edition. Prentice-Hall, India. 2008. Print.

2. Jones, S. *The Language of the Genes*. Harper Collins Publishers. 2012. Print.

3. Ridley, M. *Nature via Nurture: Genes, Experience, & What Makes Us Human*. HarperCollins Publishers. 2004. Print.

4. Aggarwal, V.K. and Verma, V.S. *Genetics.* 9th Edition. S. Chand, India. 2010. Print.

5. Snustad, D.P. and Simmons, M.J. *Principles of Genetics*. 6th Edition. John Wiley & Sons. 2011. Print.

6. Pierce, B.A. *Genetics: A Conceptual Approach.* 4th Edition. W.H. Freeman & Company, 2010. Print.

Course Code: BTY232

L	T	P	Credit
0	0	3	2

Course Title: GENETICS LABORATORY

Experiments:

1. To make squash preparations of pre-treated metaphase chromosomes, and PMCs to view diplotene, diakinesis, metaphase I and anaphase I in *Phlox drummondii*, *Allium cepa* and (or) *Rhoeo discolor*

2. Preparation of karyograms from the given photographs for karyotypic formula

3. To study through photographs normal and deviant cytogenetic mechanisms

4. Study of Mendel's laws and deviations from Mendelian ratios using seed samples in the ratios of 9:7, 9:4:3, 13:3, 15:1, 12:3:1. Use Chi-Square Test for Testing the ratios

5. Isolation of chloroplasts by sucrose gradient. Photographs of restriction site variation of chloroplast DNA

6. Exercises wrt determination of correct sequence and distance between the linked genes

7. Induction and recovery of mutants in bacteria by UV irradiation

8. Segregation demonstration in preserved material (Maize)

9. Detection of Blood groups (A B O & Rh factors)

10. Inheritance of other human characteristics, ability to test PTC, Thiourea

11. Paternity disputes (blood groups)

Course Code: BTY361

Course Title: BIOANALYTICAL TOOLS

L	T	P	Credit
4	0	0	4

UNIT I **(15 hours)**

Simple microscopy, phase contrast microscopy, florescence microscopy and Principles of electron microscopy, pH meter.

UNIT II **(15 hours)**

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

UNIT III **(15 hours)**

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 **(15 hours)**

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 their applications.

Reference Books:

1. Wilson, K. and Walker, J. *Practical Biochemistry: Principles and Techniques*. 5th Edition. Cambridge University Press. 2005. Print.

2. Iserentant, D. M. *Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes*. 1st Edition. Springer-verlag Gmbh. 1997. Print.

3. Ho, P. S., Johnson, C. and van Holde, K. E. *Principles of Physical Biochemistry*. 2nd Edition. Pearson. 2005. Print.

4. Venn, R. F. *Principles and Practice of Bioanalysis*. 1st Edition. Taylor & Francis. 2000. Print.

5. Hoppert, M. *Microscopic Techniques in Biotechnology*. 1st Edition. John Wiley & Sons. 2001. Print.

Course Code: BTY362

Course Title: BIOANALYTICAL TOOLS LABORATORY

L	T	P	Credit
0	0	3	2

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.

GENERIC ELECTIVES

Course Code: ZOO154

Course Title: ZOO DIVERSITY

L	T	P	Credit
4	0	0	4

UNIT-1

- **Protozoa:** General characters of Protozoa; life cycle of *Plasmodium* **4 hours**
- **Porifera:** General characters of Porifera; canal system in Porifera. **3 hours**
- **Radiata:** General characters of Coelenterata; Polymorphism. **3 hours**

UNIT-2

- **Acoelomates:** General characters of Helminthes; Life cycle of *Taenia solium* **3 hours**
- **Pseudocoelomates:** General characters of Nemethehelminthes; Parasitic adaptations **3 hours**

UNIT-3 **15 hours**

- **Coelomate Protostomes:** General characters of Annelida; Metamerism **3 hours**
- **Arthropoda:** General characters of Arthropoda; social life in insects **4 hours**
- **Mollusca:** General characters of Mollusca; Pearl formation **3 hours**
- **Coelomate Deuterostomes:** General characters of Echinodermata; Water vascular system in star fish **3 hours**

UNIT-4

- **Protochordata:** Salient features **2 hours**
- **Pisces:** Osoregulation. Migration of Fishes **4 hours**
- **Amphibia:** General characters, Adaptations for terrestrial life, Parental care in Amphibia **4 hours**
- **Reptilia:** Amniotes, origin of reptiles, terrestrial adaptations in reptiles **5 hours**
- **Aves:** The origin of birds; flight adaptations **5 hours**
- **Mammalia:** Early evolution of mammals; Primates; Dentition in mammals **6 hours**

Reference books

1. Kotpal, R.L., Modern Text Book of Zoology Invertebrates, 10th ed., Rastogi Publishers,
   Meerut, 2012.
2. Kotpal, R.L., Minor phyla, 5th ed., Rastogi Publishers, Meerut, 2006.
3. Dhami, P.S. and Dhami, J.K., Invertebrate Zoology, 5th ed., R. Chand & Co., New Delhi, 2004.
4. Parker, T.J. and Haswell, W.A., Text book of Zoology, Invertebrates, 7th ed., Vol. I (eds. A.J. Marshall & W.D. Williams), CBS Publishers & Distributors., Delhi, 1992.
5. Hyman L.H. The Invertebrates. Vol. I, II, III, IV and V. McGraw Hill Book Company. Inc., New York. London. Toronto, 1959.
6. Barnes, R.D. Invertebrate Zoology. Saunders College Pub. USA., 1992.
7. Ruppert, Fox and Barnes. Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole , 2006.

8. Campbell and Reece . Biology, Pearson Education, (Singapore) Pvt. Ltd, 2005
9. Kardong, K. V. Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi, 2002.
10. Raven, P. H. and Johnson, G. B. Biology, 6th edition, Tata McGraw Hill Publications. New Delhi, 2004.

Course Code: ZOO155

Course Title: ZOO DIVERSITY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Study of following specimens with the help of charts/models/e-resources;

Non Chordates: *Euglena*, *Noctiluca*, *Paramecium*, *Sycon*, *Physalia*, *Tubipora*, *Metridium*, *Taenia*, *Ascaris*, *Nereis*, *Aphrodite*, Leech, *Peripatus*, *Limulus*, Hermitcrab, *Daphnia*, Millipede, Centipede, Beetle, *Chiton*, *Dentalium*, Octopus, *Asterias*, and *Antedon*.

Chordates: *Balanoglossus*, *Amphioxus*, *Petromyzon*, *Pristis*, *Hippocampus*, *Labeo*, *Icthyophis/Uraeotyphlus*, *Salamander*, *Rhacophorus*, *Draco*, *Uromastix*, *Naja*, Viper, *Archaeopteryx*, any three common birds-(Crow, duck, Owl), Squirrel and Bat.

2. Study of following through e-resources:
Cross section of *Sycon*, Sea anemone and *Ascaris* (male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva, Septal & pharyngeal nephridia of earthworm, Placoid, cycloid and ctenoid scales.

3. Study of the following through e-resources:
- Digestive and nervous system of Cockroach.
- Urinogenital system of Rat

Course Code: BOT131

Course Title: PLANT DIVERSITY

L	T	P	Credit
4	0	0	4

UNIT 1 **(15 hours)**

Viruses: Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

UNIT 2 **(15 hours)**

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

Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

UNIT 3 **(15 hours)**

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

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

UNIT 4 **(15 hours)**

Pteridophytes: General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. Heterospory and seed habit, stellar evolution.Ecological and economical importance of Pteridophytes.

Gymnosperms: General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. Ecological and economical importance.

SUGGESTED READINGS

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi.
2^{nd} edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10^{th} edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4^{th} edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

Course Code: BOT132

Course Title: PLANT DIVERSITY LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus** and *Polysiphonia* through temporary preparations and permanent slides. (* Fucus - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
12. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
14. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore,w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
17. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Course Code: BOT241

Course Title: PLANT PHYSIOLOGY AND METABOLISM

L	T	P	Credit
4	0	0	4

UNIT 1 **(15 hours)**

Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

UNIT 2 **(15 hours)**

Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

UNIT 3 **(15 hours)**

Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

UNIT 4 **(15 hours)**

Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

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

SUGGESTED READINGS

1. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Course Code: BOT242

Course Title: PLANT PHYSIOLOGY AND METABOLISM LABORATORY

L	T	P	Credit
4	0	0	4

Experiments:

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

Demonstration experiments (any four)

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

Course Code: BTY243

Course Title: BIOTECHNOLOGY & HUMAN WELFARE

L	T	P	Credit
4	0	0	4

UNIT 1 **(15 hours)**

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT 2 **(15 hours)**

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT 3 **(10 hours)**

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT 4 **(10 hours)**

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT 5 **(10 hours)**

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

Course Code: BTY244

Course Title: BIOTECHNOLOGY AND HUMAN WELFARE LABORATORY

L	T	P	Credit
0	0	3	2

Experiments:

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

Course Code: PHY155A

Course Title: OPTICS AND LASERS

L	T	P	Credit
4	0	0	4

Aim: The aim and objective of the course on Optics and Lasers for the students of B.Sc. (Hons) Chemistry, Mathematics, Microbiology is to enable them to understand the different phenomenon exhibited by the light as well as the basics of the laser light.

UNIT- I
INTERFERENCE (15 h):
Young's double slit experiment, Coherent Source, Theory of interference fringes, Types of interference, Fresnel's biprism, thickness of thin transparent sheet, Interference in thin films, Newton's rings and their application, Michelson Interferometer, Application of thin film interference; Anti reflection coatings; dielectric mirrors; interference filters; Holography.

UNIT- II
DIFFRACTION (15 h):
Difference between Fresnel and Franunhoffer diffraction, Franunhoffer diffraction at a single slit and its discussion, Fraunhoffer diffraction at double slit, missing orders in a double slit, Diffraction of N slits and its discussion, Diffraction grating, Missing orders, dispersive power, Rayleigh Criterion for resolving power, resolving power of a diffraction grating.

UNIT- III
POLARIZATION (15 h):
Polarised light and its production; polarisers and analyzers; anisotropic crystals; Polarization by transmission and reflection, Malus Law, Brewster's Law, Polarization by refraction, anisotropic crystals, Theory of double refraction, Elliptically and circularly polarized light, Quarter wave and half wave plates, Production and detection of polarized light, Optical activity, specific rotation. Half shade polarimeter; LCD's.

UNIT- IV
LASERS (15 h):
Attenuation of light in an optical medium; thermal equilibrium; interaction of light with matter; Einstein relations; light amplification; population inversion; active medium, pumping; metastable states; principle pumping schemes; optical resonant cavity; axial modes; gain curve and laser operating frequencies, transverse modes; types of lasers; Q-switching; laser beam characteristics and applications.

Suggested Books:
1. Subramanayam, N., Lal,B.& Avadhamulu, M. N. Textbook of Optics. New Delhi: S. Chand &
Company, 2006.
2. Jenkins, F.A., White, H.E. Fundamentals of Optics.USA: McGraw Hill Publication, 1976.
3. Ghatak,A.,Optics. New Delhi: Tata McGraw Hill Publication, 2008.

Course Code: PHY154

Course Title: OPTICS LABORATORY

L	T	P	Credit
0	0	3	2

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipments.

Note:
• Students are expected to perform at least eight-ten experiments out of following list. The experiments performed in first semester cannot be repeated in second Semester.
• The examination for both the courses will be of 3 hours duration

List of Experiments:
Experimental skills: General Precautions for measurements and handling of equipment, representation of measurements, Fitting of given data to a straight line, and Error analysis, Significant figures and interpretation of results.

List of Experiments: Students are expected to perform at least eight experiments out of following list.
1. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
2. To determine the Dispersive Power of the Material of a given Prism using Mercury Light.
3. To determine the Resolving Power of a Prism.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine the Thickness of a Thin Paper by measuring the Width of the Interference Fringes produced by a Wedge Shaped Film.
7. To determination Wavelength of Sodium Light using Michelson's Interferometer.
8. To determine the wavelength of Laser light using Diffraction of Single Slit.
9. To determine the wavelength of (1) Sodium and (2) Mercury Light using Plane Diffraction Grating.
10. To determine the Dispersive Power of a Plane Diffraction Grating.
11. To determine the Resloving Power of a Plane Diffraction Grating.
12. To determine the (1) Wavelength and (2) Angular Spread of HeNe Laser using Plane Diffraction Grating.
13. To study the wavelength of spectral lines of sodium light using plane transmission grating.
14. To study the specific rotation of sugar solution Laurents half shade polarimeter method
15. To study the numerical aperture and propagation losses using He-Ne laser Optical fibre set up.
16. To compare the focal length of two lenses by Nodal slide method.

Course Code: CHE157

Course Title: GENERAL CHEMISTRY- I

L	T	P	Credit
4	0	0	4

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Section A: Inorganic Chemistry-1 (30 Periods)

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers *n, l* and *m.* Shapes of *s, p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizabilty. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

Section B: Organic Chemistry-1 (30 Periods)

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L *cis – trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$ ozonolysis and oxidation with hot alk. $KMnO_4$

Reference Books:

• J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
• F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
• Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*, John Wiley.
• James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
• T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.
• Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
• E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
• I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
• R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
• Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand

Course Code: CHE158

Course Title: General Chemistry – I Laboratory

L	T	P	Credit
0	0	3	2

Experiments:

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ with internal indicator.

5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).

2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given):

(a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography

(b) Identify and separate the sugars present in the given mixture by paper chromatography.

Course Code: CHE257

Course Title: GENERAL CHEMISTRY– II

L	T	P	Credit
4	0	0	4

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Section A: Physical Chemistry-1 **(30 Lectures)**

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between *Kp, Kc* and *Kx* for reactions involving ideal gases.

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Organic Chemistry-2 **(30 Lectures)**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution reactions.

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 or NaNH2.

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Alcohols: *Preparation:* Preparation of primary, secondary and tertiary alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. $HNO_{3)}$. Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann
Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)
Preparation: from acid chlorides and from nitriles.
Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books:

• T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons*.
• Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry,* Orient Longman.
• I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
• R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
• Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand.
• G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
• G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa (2004).
• J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Lening India Pvt. Ltd., New Delhi (2009).
• B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
• R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

Course Code: CHE258

Course Title: General Chemistry – II Laboratory

L	T	P	Credit
0	0	3	2

Experiments:

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:

(i) Sodium acetate-acetic acid

(ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done.

(a) Bromination of Phenol/Aniline

(b) Benzoylation of amines/phenols

(c) Oxime and 2, 4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

• A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
• F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
• B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

SKILL ENHANCEMENT COURSES

Course Code: MIC261

Course Title: MANAGEMENT OF HUMAN MICROBIAL DISEASES

L	T	P	Credit
2	0	0	2

Course Objective: This course is designed with the aim of providing an insight into the various aspects of some significant human diseases caused by microbes, their therapeutic and prophylactic measures.

Course Content:

Unit 1 Human Diseases **No of Hours: 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 **No of Hours: 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 **No of Hours: 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 **No of Hours: 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.

Suggested Readings

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

Course Code: MIC262

Course Title: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

L	T	P	Credit
2	0	0	2

Course Objective: The objective of this course is allow the students to develop an understanding about the clinical microbiology especially about sample collection and various diagnostic approaches based on microscopic studies, cultural techniques, serological and molecular techniques etc.

Course Content:

Unit 1 Importance of Diagnosis of Diseases **No of Hours: 5**
Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit 2 Collection of Clinical Samples **No of Hours: 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. **No of Hours: 5**
Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained 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 **No of Hours: 5**
Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Unit 5: Kits for Rapid Detection of Pathogens **No of Hours: 5**
Typhoid, Dengue and HIV, Swine flu

Unit 6: Testing for Antibiotic Sensitivity in Bacteria **No of Hours: 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

SUGGESTED READINGS

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

Course Code: MIC266

Course Title: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

L	T	P	Credit
2	0	0	2

Course Objective: This course will help the students to understand about the microflora associated with air and water, various methods of their assessment and control.

Course Content:

Unit 1 Aeromicrobiology **No of Hours: 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, Advantages and constraints of biofertilizers over chemical fertilizers

Unit 2 Air Sample Collection and Analysis **No of Hours: 7**

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

Unit 3 Control Measures **No of Hours: 4**

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

Unit 4 Water Microbiology **No of Hours: 4**

Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water **No of Hours: 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

Unit 6 Control Measures **No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light

SUGGESTED READINGS

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR. Microbiological Examination Methods of Food and Water: A Laboratory Manual. CRC Press. 2012. Print

2. Atlas RM and Bartha R. Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA. 2000. Print

3. Maier RM, Pepper IL and Gerba CP. Environmental Microbiology. 2nd edition. Academic Press. 2009. Print

4. Hurst CJ, Crawford RL, Garland JL, Lipson DA. Manual of Environmental Microbiology, 3rd edition, ASM press. 2007. Print

Course Code: MIC264

Course Title: FOOD FERMENTATION TECHNIQUES

L	T	P	Credit
2	0	0	2

Course Objective: The aim of this course is to provide an insight into the fundamentals of various types of food fermentation processes based on milk, vegetables, grains, meats and probiotics.

Course Content:

Unit 1 Fermented Foods **No of Hours: 4**
Definition, types, advantages and health benefits
Unit 2 Milk Based Fermented Foods **No of Hours: 8**
Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process
Unit 3 Grain Based Fermented Foods **No of Hours: 6**
Soy sauce, Bread, Idli and Dosa: Microorganisms and production process
Unit 4 Vegetable Based Fermented Foods **No of Hours: 4**
Pickels, Saeurkraut: Microorganisms and production process
Unit 5 Fermented Meat and Fish **No of Hours: 4**
Types, microorganisms involved, fermentation process
Unit 6 Probiotic Foods **No of Hours: 4**
Definition, types, microorganisms and health benefits

SUGGESTED READINGS

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS. *Handbook of food and fermentation technology.* CRC Press. 2004. Print
2. Holzapfel W. *Advances in Fermented Foods and Beverages*. Woodhead Publishing. 2014. Print
3. Yadav JS, Grover, S and Batish VK. *A comprehensive dairy microbiology*. Metropolitan. 1993. Print

ABILITY ENHANCEMENT COURSES

Course Code: ENG151B

Course Title: BASIC COMMUNICATIONS SKILLS

L	T	P	Credit
3	1	0	3

Course Objectives:

- To enhance students' vocabulary and comprehension skills through the prescribed texts.
- To hone students' reading and writing skills.
- To teach the rules of English grammar descriptively.
- To make students aware about the socio-cultural aspect of English.

Learning Outcomes: Students will

- Have developed a wide vocabulary and be able to summarize ideas.
- Be able to read and analyze texts and display competence in written communication.
- Show a considerable understanding of English Grammar.
- Demonstrate sensitivity to cultural differences while communicating

Unit – A

1. **Applied Grammar (in Socio-Cultural Context)**
    - Tenses
    - Passives
    - Reported/Reporting Speech

Unit – B

1. **Reading (Communicative Approach to be Followed)**

    - Nissim Ezekiel : The Patriot (Poem)

(Sub-topic: Basic Introduction to Indianisms and Difference between Indian English & Standard English)

2. **Writing**

    - Paragraph Writing : Topic Sentence, Inductive logic, and Deductive logic
    - Essays: Narrative, Descriptive, Expository, and Persuasive
    - Notice: Format, Characteristics, and 5 W's,

- Email: Structure, Characteristics of Effective Emails, and Advantages

Unit – C

1. **Applied Grammar (in Socio-Cultural Context)**

    - Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, and Interjection
    - Modals: Can, Could, May, Might, Will, Would, Shall, Should, and Must

Unit – D

1. **Reading (Communicative Approach to be Followed)**

    Alleen Pace Nilsen: Sexism in English (Prose)

    (Sub-topic: Relationship between Society & Language and Sexist Language)

2. **Writing**

    Letter Writing: Formal and Informal

Teaching Methodology:

a. **Grammar:** Grammar must be taught descriptively in socio-cultural context. The contextual teaching of grammar helps a learner understand the application of grammar rules in real life situations. The learner who learns grammar in isolation is unable to use the language fluently, whereas the learner who learns grammar in context uses the language confidently and fluently in real life situations.

b. **Literary Texts:** Communicative approach should be followed to teach the texts. Classroom activities guided by the communicative approach are characterised by trying to produce meaningful and real communication, at all levels. As a result there may be more emphasis on skills than systems, lessons are more learner-centred, and there may be use of authentic materials.

    Teachers can introduce the topic or theme of the text, pre-teach essential vocabulary items and use prediction tasks to arouse the interest and curiosity of students.

c. **Writing**: Some of the strategies that should be adopted are as follows:

- Regularly assign brief writing exercises in your classes.
- Provide guidance throughout the writing process, i.e. Pre-Writing, Drafting, Revising, Editing, and Publishing.
- Give students opportunities to talk about their writing.
- Encourage students to revise their work.

Testing: The examinations will be conducted as per the norm of the university.

References:

a. Books

1. Eschholz, Paul and Rosa, Alfred (ed.), *Subject and Strategy*. NY: St. Martin's Press, 1978. Print.
2. Ezekiel, Nissim. *Collected Poems 1952-1988*. New Delhi: Oxford University Press, 1999. Print.
3. Hosler, Mary Margaret. *English Made Easy*. Delhi: McGraw, 2013. Print.
4. Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.
5. Mahanand, Anand. *English for Academic and Professional Skills*. Delhi: McGraw, 2013. Print.
6. Rani, D Sudha, TVS Reddy, D Ravi, and AS Jyotsna. *A Workbook on English Grammar and Composition*. Delhi: McGraw, 2016. Print.
7. Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2018. Print.
8. Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.
9. Tyagi, Kavita and Padma Misra. *Basic Technical Communication*. Delhi: PHI Learning, 2013. Print.

b. Websites

1. www.youtube.com (to watch standard videos)
2. http://learnenglish.britishcouncil.org/en
3. https://owl.english.purdue.edu/

Course Title: Basic Communication Skills Lab.

Course Code: ENG 152A

L	T	P	Credits
0	0	2	1

Course Objectives:

- To improve the preparation and presentation competencies necessary for oral communication in a variety of contexts, as both a speaker and a listener.
- To improve pronunciation.
- To promote interactive skills through Group Discussions and role plays.

Learning Outcomes: Students will be able to:

- Develop proper listening skills
- Articulate and enunciate words and sentences clearly and efficiently
- Show confidence and clarity in public speaking projects

Unit – A Speaking and Listening
• IPA for Language Learning - Basic Phonetics
• Movie-Clippings
• Role Plays
• Group Discussions
• Mock Interviews

Project File: Each student will prepare a project file on any of the topics given by class teacher. Student should be able to justify the contents of his/her scrap file. The file must be handwritten, not typed. Students must acknowledge all the sources of information in his/her scrap file.

Testing: The end term lab. examination will be conducted as per the norm of the university. The distribution of marks in the end-term lab. examination is as follows:

Component	**Weightage**
Project File Marks will be given for originality, creativity and presentation. Student will receive credit	**30 %**

for his/her command of the language also.	
Lab. Activity It may include dialogue writing (Dialogue to Prose and Prose to Dialogue), writing about a picture/some object, writing a report, writing on a topic of general interest, listening exercise, English phonetic exercise, etc. It will be decided by examiner on the spot.	**30%**
Viva Voce Questions will be based on the project file. Examiner may ask other non-technical questions related to student's life and interests.	**40%**
Total	**100%**

For the final result, marks will be calculated as per the criterion laid down by the university:

Component	**Weightage**
Marks Obtained in the lab examination	**80%**
Continuous Assessment (Based on Student's Regularity & Class Performance)	**20%**
Total	**100%**

Reference Books

c. Books

10. Crystal, David. *The Gift of the Gab – How Eloquence Works*. Connecticut: Yale University, 2016. Print.

11. Gangal, J. K. *A Practical Course in Spoken English*. India: Phi Private Limited, 2012. Print.

12. Hosler, Mary Margaret. *English Made Easy*. Delhi: McGraw, 2013. Print.

13. Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.

14. Mahanand, Anand. *English for Academic and Professional Skills*. Delhi: McGraw, 2013. Print.

15. Rani, D Sudha, TVS Reddy, D Ravi, and AS Jyotsna. *A Workbook on English Grammar and Composition*. Delhi: McGraw, 2016. Print.

16. Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2018. Print.

17. Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.

18. Suzana, Roopa. *A Practical Course in English Pronunciation*. Delhi: McGraw Hill Education, 2017. Print.

19. Tyagi, Kavita and Padma Misra. *Basic Technical Communication*. Delhi: PHI Learning, 2013. Print.

d. Websites

4. www.youtube.com (to watch standard videos)
5. http://learnenglish.britishcouncil.org/en
6. https://owl.english.purdue.edu/

Course Code: EVS100

Course Title: ENVIRONMENTAL STUDIES

L	T	P	Credit
4	0	0	4

Unit 1

The multidisciplinary nature of environmental studies (2 Hours)

Definition, scope and importance, Need for public awareness

Natural Resources: Renewable and non-renewable resources: (8 Hours)

Natural resources and associated problems.

(a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

(b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

(c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

(d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

(e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

(f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Ecosystem: (4 Hours)

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

Unit 2

Biodiversity and its conservation 4 Hours

- Introduction – Definition: Genetic, Species and Ecosystem Diversity
- Bio-geographical classification of India
- Value of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts
- Endangered and endemic species of India

- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, global and national efforts.

Environmental Pollution **8Hours**

- Definition, causes, effects and control measures of:

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear pollution

- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

Unit 3

Social Issues and the Environment **7 Hours**

- Population growth, variation among nations, Population explosion – Family Welfare Programmes.
- Environment and human health,
- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Laws: The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and control of Pollution) Act 1974; The Wildlife Protection Act, 1972; Forest Conservation Act, 1980.
- Issues involved in enforcement of environmental legislation
- Public Awareness

Unit 4

Human Population and Environment5 Hours

- Population Growth and Variations among Nations
- Population Explosion
- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

Field Work **5 Hours**

- Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-Pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

Suggested Readings:

1. Odum, EP. *Basic Ecology*. Japan: Halt Saundurs, 1983.
2. Botkin, DB, and Kodler EA. *Environmental Studies: The Earth as a living planet.* New York: John Wiley and Sons Inc., 2000.
3. Singh, JS, Singh, SP, and Gupta SR. Ecology, *Environment and Resource Conservation.* New Delhi: Anamaya Publishers, 2006.
4. De, AK. *Environmental Chemistry*. New Delhi: Wiley Eastern Ltd., 1990.
5. Sharma, PD. *Ecology and Environment*. Meerut Rastogi Publications, 2004

Course Code: SGS107

Course Title: GENERAL KNOWLEDGE & HUMAN VALUES

L	T	P	Credit
4	0	0	4

Part - A

Human Values

1. **Concept of Human Values:** Meaning, Types and Importance of Values. **2 Hrs**
2. **Value Education :** Basic guidelines for value education **2 Hrs**
3. **Value crisis and its redressal** **1 Hrs**

Being Good and Responsible

1. Self Exploration and Self Evaluation **2 Hrs**
2. Acquiring Core Values for Self Development **2 Hrs**
3. Living in Harmony with Self, Family and Society **3 Hrs**
4. Values enshrined in the Constitution: Liberty, Equality Fraternity and Fundamental Duties. **3 Hrs**

Part - B

Value – based living

1. Vedic values of life **2 Hrs**
2. *Karma Yoga* and *Jnana Yoga* **2 Hrs**
3. *Ashta Marga* and *Tri-Ratna* **2 Hrs**

Ethical Living:

1. Personal Ethics **2 Hrs**
2. Professional Ethics **3 Hrs**
3. Ethics in Education **2 Hrs**

Part-C

General Geography

World Geography **3 Hrs**

The Universe, The Solar System, The Earth, Atmosphere, The World we live in, Countries rich in Minerals, Wonders of the World, Biggest and Smallest.

Indian Geography **3 Hrs**

Location, Area and Dimensions, Physical Presence, Indian States and Union Territories, Important sites and Monuments, Largest-Longest and Highest in India.

General History **3 Hrs**

Glimpses of India History, Ancient Indian, Medieval India, Modern India, Various Phases of Indian National Movement, Prominent Personalities, Glimpses of Punjab history with special reference to period of Sikh Gurus

Glimpses of World History **3 Hrs**

Important Events of World History, Revolutions and Wars of Independence, Political Philosophies like Nazism, Fascism, Communism, Capitalism, Liberalism etc.

Indian Polity: Constitution of India **3 Hrs**

Important Provisions, Basic Structure, Union Government, Union Legislature and Executive, State Government: State Legislature and Executive, Indian Judiciary, The Election Commission, Panachayati Raj System, RTI etc.

General Economy **3 Hrs**

The process of liberalization, privatization, globalization and Major World Issues, Indian Economy, Indian Financial System, Major Economic Issues, Economic Terminology.

Part-D

General Science **3 Hrs**

General appreciation and understandings of science including the matters of everyday observation and experience, Inventions and Discoveries

Sports and Recreation **3 Hrs**

The World of Sports and recreation, Who's Who is sports, Major Events, Awards and Honours. Famous personalities, Festivals, Arts and Artists

Current Affairs **3 Hrs**

National and International Issues and Events in News, Governments Schemes and Policy Decisions

Miscellaneous Information

Who is who **2 Hrs**

Books and Authors, Persons in News, Awards and Honours, Abbreviations and Sports

References:

1. Human Values, A N Tripathi, New Age International Publishers, New Delhi, Third Edition, 2009
2. Professional Ethics, R. Surbiramanian, Oxford University Press, New Delhi, 2013.
3. Human Values and Professional Ethics, Rishabh Anand, Satya Prakashan, New Delhi, 2012
4. Human Values and Professional Ethics, Sanjeev Bhalla, Satya Prakashan, New Delhi, 2012.
5. Human Values and Professional Ethics, Ritu Soryan Dhanpat Rai & Co. Pvt. Ltd., First Edition, 2010.
6. Human Values and Professional Ethics by Suresh Jayshree, Raghavan B S, S Chand & Co. Ltd. , 2007.
7. Human Values and Professional Ethics, Yogendra Singh, Ankur Garg, Aitbs publishers, 2011.
8. Human Values and Professional Ethics, Vrinder Kumar, Kalyani Publishers, Ludhiana, 2013.
9. Human Values and Professional Ethics, R R Gaur, R. Sangal, GP Bagaria, Excel Books, New Delhi 2010.
10. Values and Ethics, Dr. Bramwell Osula, Dr. Saroj Upadhyay, Asian Books Pvt. Ltd., 2011.
11. Indian Philosophy, S. Radhakrishnan, George Allen & Unwin Ltd., New York: Humanities Press INC, 1929.
12. Essentials of Hinduism, Jainism and Buddhism, A N Dwivedi, Books Today, New Delhi – 1979
13. Dayanand : His life and work, Suraj Bhan, DAVCMC, New Delhi – 2001.
14. Esence of Vedas, Kapil Dev Dwivedi, Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
15. Vedic Concepts, Prof. B B Chaubey, Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
16. Advance Objective General Knowledge, R. S. Aggarwal, S. Chand Publisher (2013)
17. Concise General Knowledge Manual 2013, S. Sen, Unique Publishers,2013
18. Encyclopedia of General Knowledge and General Awareness by R P Verma, Penguin Books Ltd (2010)
19. General Knowledge Manual 2013-14, Edgar Thorpe and Showick Thorpe, The Pearson, Delhi.
20. General Knowledge Manual 2013-14, Muktikanta Mohanty, Macmillan Publishers India Ltd., Delhi.

21. India 2013, Government of India (Ministry of Information Broadcasting), Publication Division, 2013.
22. Manorama Year Book 2013-14, Mammen Methew, Malayalam Manorama Publishers, Kottayam, 2013.
23. Spectrum's Handbook of General Studies – 2013-14, Spectrum Books (P) Ltd., New Delhi

CURRENT AFFAIRS

Magazines

Economic and Political Weekly, Yojna, the Week, India Today, Frontline, Spectrum.
Competition Success Review, Competition Master, Civil Services Chronicle, Current Affairs, World Atlas Book

Newspapers

The Hindu, Times of India, The Hindustan Times, The Tribune