# PROPOSED SYLLABUS

# AND

# SCHEME OF EXAMINATION

# For

# B.Sc. MICROBIOLOGY

## (FOUR YEAR UNDER GRADUATE PROGRAMME)

## Under

## NEW EDUCATION POLICY

## 2020

**Submitted by**

## DEPARTMENT OF MICROBIOLOGY

## DR SHYAMA PRASAD MUKHERJEE UNIVERSITY

## RANCHI

**Course Structure for Four years Undergraduate Programme under NEP 2020**

| Sl. no | SEMESTERS | Paper Code | Papers | Credit | Marks |
|---|---|---|---|---|---|
| | MAJOR COURSE | | | | |
| 1 | SEMESTER-1 | MJ-101 | General Microbiology | 4 (3+1) | 75+25=100 |
| 2 | SEMESTER-2 | MJ-201 | Bacteriology | 4 (3+1) | 75+25=100 |
| 3 | | MJ-202 | Bacterial Systematics | 4 (3+1) | 75+25=100 |
| 4 | SEMESTER-3 | MJ-301 | Biochemistry | 4 (3+1) | 75+25=100 |
| 5 | | MJ-302 | Virology | 4 (3+1) | 75+25=100 |
| 6 | SEMESTER-4 | MJ-401 | Microbial Physiology and Metabolism | 4 (3+1) | 75+25=100 |
| 7 | | MJ-402 | Cell Biology | 4 (3+1) | 75+25=100 |
| 8 | | MJ-403 | Molecular Biology | 4 (3+1) | 75+25=100 |
| 9 | SEMESTER-5 | MJ-501 | Inheritance Biology | 4 (3+1) | 75+25=100 |
| 10 | | MJ-502 | Plant Pathology | 4 (3+1) | 75+25=100 |
| 11 | | MJ-503 | Environmental Microbiology | 4 (3+1) | 75+25=100 |
| 12 | SEMESTER-6 | MJ-601 | Food and Dairy Microbiology | 4 (3+1) | 75+25=100 |
| 13 | | MJ-602 | Microbial Genetics | 4 (3+1) | 75+25=100 |
| 14 | | MJ-603 | Immunology | 4 (3+1) | 75+25=100 |
| 15 | | MJ-604 | Medical Microbiology | 4 (3+1) | 75+25=100 |
| 16 | SEMESTER-7 | MJ-701 | Bioinformatics | 4 (3+1) | 75+25=100 |
| 17 | | MJ-702 | Recombinant DNA Technology | 4 (3+1) | 75+25=100 |
| 18 | | MJ-703 | Industrial Microbiology | 4 (3+1) | 75+25=100 |
| 19 | | MJ-704 | Analytical Techniques | 4 (3+1) | 75+25=100 |
| 20 | SEMESTER-8 | MJ-801 | Biostatistics | 4 (3+1) | 75+25=100 |
| 21 | | | Research Course I<br>Research Course II<br>Research Course III | 4<br>4<br>4 | |

| | | | | | |
|---|---|---|---|---|---|
| 22 | | MJ-801 | Biostatistics | 4 (3+1) | 75+25=100 |
| 23 | | AMJ-801 | Bioremediation | 4 (3+1) | 75+25=100 |
| 24 | | AMJ-802 | Microbial Biotechnology | 4 (3+1) | 75+25=100 |
| 25 | | AMJ-803 | Agricultural Microbiology | 4 (3+1) | 75+25=100 |
| | MINOR COURSE | | | | |
| 26 | SEMESTER 1 | MN-101 | Introduction and scope of Microbiology | 4 (3+1) | 75+25=100 |
| 27 | SEMESTER 3 | MN-301 | Bacteriology and Virology | 4 (3+1) | 75+25=100 |
| 28 | SEMESTER 5 | MN-501 | Industrial and food microbiology | 4 (3+1) | 75+25=100 |
| 29 | SEMESTER 7 | MN-701 | Microbes in Environment | 4 (3+1) | 75+25=100 |
| | MINOR COURSE (Vocational) | | | | |
| 30 | SEMESTER 2 | MVC-201 | Soil Microbiology and Biofertilizer technology | 4 (3+1) | 75+25=100 |
| 31 | SEMESTER 4 | MVC-401 | Food dairy and beverage management | 4 (3+1) | 75+25=100 |
| 32 | SEMESTER 6 | MVC-601 | Microbial Diagnosis in Health Clinic | 4 (3+1) | 75+25=100 |
| 33 | SEMESTER 8 | MVC-801 | Mushroom cultivation | 4 (3+1) | 75+25=100 |
| | SKILL ENHANCEMENT COURSE | | | | |
| 34 | SEMESTER 1 | SEC-101 | Biofertilizers and Biopesticides | 3(2+1) | 50+25=75 |
| 35 | SEMESTER 2 | SEC-201 | Food Fermentation techniques | 3(2+1) | 50+25=75 |
| 36 | SEMESTER 3 | SEC-301 | Microbiological Analysis of Air and Water | 3(2+1) | 50+25=75 |

**B.Sc. MICROBIOLOGY SEMESTER –I**

**MJ-101T: GENERAL MICROBILOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

**Outcome 2.** Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

**Outcome 3.** Are able to explain the useful and harmful activities of the microorganisms.

**Outcome 4.** Are able to perform basic experiments to grow and study microorganisms in the laboratory.

**Unit 1 History of Development of Microbiology** **No. of Hours: 13**

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. 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: 35**

**A. Systems of classification**

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between Prokaryotic and Eukaryotic microorganisms

- **General characteristics** of different groups: **Acellular** microorganisms (Viruses,Viroids,Prions)
- **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, 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: 2**

**MJ- 101P: GENERAL MICROBILOGY (PRACTICAL) SEMESTER –I**

**TOTALHOURS: 30** **CREDITS: 1**

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. Demonstration of the presence of Microflora in the environment by exposing nutrient agar plates to air.
7. Study of *Rhizopus*, *Penicillium, Aspergillus* using temporary mounts.
8. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary mounts.
9. Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium* and *Plasmodium.*

**SUGGESTED READING**


1. Tortora G J, Funke B R and Case C L (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

2. Madigan M T, Martinko J M, Dunlap P V and Clark D P (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

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

4. Wiley J M, Sherwood L M and Woolverton C J (2013) Prescott's Microbiology 9th Edition. McGraw Hill International.

5. Atlas R M (1997) Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.

6. Pelczar M J, Chan ECS and Krieg N R (1993). Microbiology 5th edition. McGraw Hill Book Company.

7.Stanier R Y, Ingraham J L, Wheelis M L, and Painter PR (2005). General Microbiology 5th edition. McMillan.

## B.Sc. MICROBIOLOGY SEMESTER –II

**MJ-201T: BACTERIOLOGY (THEORY)**

**TOTALHOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the completion of this course, the students are able to

**Outcome 1.** Describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics; classify bacteria into groups.

**Outcome 3.** Describe the nutritional requirements of bacteria for growth; developed knowledge and understanding that besides common bacteria there are several other microbes which grow under extreme environments.

**Outcome 4.** Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

**Unit 1 Cell organization** **No. of Hours: 12**

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. 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: 5**

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

**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. *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 Important Archaeal and Eubacterial groups** **No. of Hours: 12**

**Archaea**: General characteristics, Phylogenetic overview.

**Eubacteria:** Morphology, metabolism, ecological significance and economic

importance of following groups:

***Gram Negative:*** General characteristics with suitable examples.

***Gram Positive:*** General characteristics with suitable examples.

***Cyanobacteria*****:** An Introduction.

**MJ-201P: BACTERIOLOGY (PRACTICAL) SEMESTER –II**

**TOTALHOURS: 30 CREDITS: 1**

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.

**SUGGESTED READINGS**

1. Atlas R M. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.

2. Black J G (2008) Microbiology: Principles and Explorations 7th edition PrenticeHall

3. Madigan M T, and Martinko J M (2014). Brock Biology of Micro-organisms 14th edition Parker J. Prentice Hall International, Inc.

4. Pelczar Jr M J, Chan ECS, and Krieg N R (2004). Microbiology. 5th edition Tata McGraw Hill.

5. Srivastava S and Srivastava P S (2003). Understanding Bacteria Kluwer Academic

Publishers, Dordrecht

6. Stanier R Y, Ingraham J L, Wheelis M L and Painter P R (2005). General Microbiology 5th edition McMillan.

## B.Sc. MICROBIOLOGY SEMESTER –II

**MJ-202T: BACTERIAL SYSTEMATICS (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** By the end of this course the students-

**Outcome 1.** Describe the Bacterial and Fungal systematics including classification, nomenclature and identification. The students will be able to understand that taxonomy and systematics are synonymous.

**Outcome 2.** Differentiate a large number of common bacteria by their salient characteristics, classify bacteria into groups and also diffentiate Eubacteria and Archaea.

**Outcome 3.** To understand significance and potential application of Archaea and Bacteria,Fungi.

**Outcome 4.** To develop knowledge and understanding that besides common bacteria thereare several other microbes which grow under extreme environments.

**Unit 1 Bacterial Systematics** **No. of Hours: 7**

Aim and principles of Classification, Systematic 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 Archaea.

**Unit 2 Archaea** **No of hours: 8**

Systematics, and occurrence, diversity, characteristic features, significance and potential applications Eg., Biochips, Methane generation, ultrafiltration membranes, production of PHB and PHA, Desulphurization of coal and crude oil, Bioleaching of Metals, Enzymes.

**Unit 3 Bacteria** **No of hours: 8**

Conventional and molecular systematics, and general discussion on the occurrence, diversity, characteristic features, significance and potential applications of various groups of bacteria according to Bergey's Manual of Systematic Bacteriology.

**Unit 4 Fungal Systematics and diversity** **No of hours: 12**

Endophytic fungi, colonization and adaptation of Endophytes. Endophytes as latent pathogens and biocontrol agents.

**Mycorrhizal fungi:** Diversity of Endo- and Ecto-mycorrhizal fungi, benefits and recent advances in the field of Mycorrhiza. Agriculturally important toxigenic fungi: Biodiversity, Chemical and Biological characterization of toxic metabolites, toxigenic fungi in sustainable agriculture with special emphasis on Biopesticides.

**Yeasts:** Yeasts as producers of bioactive molecules such as pigments, lipids, organic acids and EPS, yeasts as Probiotics, Yeasts in Bioremediation, and Yeasts in alcoholic fermentations.

**Unit 6 Principles of Bacterial Taxonomy:** **No. of hours: 10**

Principles of Bacterial Taxonomy and Classification: - Concepts, Nomenclature and Taxonomic ranks: General properties of Bacterial groups. Major characteristics used in Taxonomy- Morphological, Physiological and Metabolic, Ecological, Numerical taxonomy, Genetic and Molecular classification systems; the kingdoms of organisms and Phylogenetic trees. Distinguishing characteristics between Prokaryotic and Eukaryotic cells Structure and function of Cell wall of bacteria, Cell membranes, Flagella, Pili, Capsule, Gas vesicles, Carboxysome, Magnetosome and Phycobilisome.

**MJ-202P: BACTERIAL SYSTEMATICS (PRACTICAL) SEMESTER –II**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Study the culture characteristic of Fungi and Bacteria
2. Method for isolating pure culture of bacteria (By Streak-Plate technique, Pour Plate and Spread Plate techniques)
3. Methods of culture preservation and maintenance by sub-culturing.
4. Measurement of microorganisms (Micrometery)
5. Methods for staining of microorganisms
    a) Simple staining for study of microorganisms
    b) Gram's staining for differentiation of bacteria
    c) Negative staining of bacteria
    d) Endospore staining
    e) Staining of fungi
6. Isolation and enumeration of bacteria from the soil sample
7. Isolation and enumeration of fungi from the soil sample

**SUGGESTED READING**


1. Madigan M T, Martinko J M, Dunlap P V and Clark D P (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

2. Cappucino J and Sherman N (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

3. Wiley J M, Sherwood L M and Woolverton C J. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

4. Atlas R M. (1997). Principles of Microbiology. 2nd edition. W M.T. Brown Publishers.

5. Pelczar M J, Chan E C S and Krieg N R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

6. Stanier R Y, Ingraham J L, Wheelis M L, and Painter P R. (2005). General Microbiology. 5th edition. McMillan.

## B.Sc. MICROBIOLOGY SEMESTER –III

**MJ-301T: BIOCHEMISTRY (THEORY)**

**TOTALHOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** By the end of this course the students-

**Outcome 1.** Developed a very good understanding of various Biomolecules which are required for development abd functioning of a bacterial cell.

**Outcome 2.** Have developed how the carbohydrates make the structural and functional components such as energy generation and as storage food molecules for the bacterial cells.

**Outcome 3.** Well conversant about multifarious function of proteins; are able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics; also knowledge about lipids and nucleic acids.

**Outcome 4.** Students are able to make buffers, study enzyme kinetics and calculate Vmax, Km, Kcat values.

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

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, Enthalpy, Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant. Coupled reactions and additive nature of standard

free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3-Bisphosphoglycerate, Thioesters, ATP.

**Unit 2 Carbohydrates** **No. of Hours: 9**

Families of Monosaccharides: Aldoses and Ketoses, Trioses, Tetroses, Pentoses, and Hexoses.

Stereo isomerism of Monosaccharides, Epimers, Mutarotation and Anomers of Glucose. Furanose and Pyranose forms of Glucose and Fructose, Haworth projection formulae for Glucose; Chair and Boat forms of glucose, Sugar derivatives, Glucosamine, Galactosamine, Muramic acid, N-acetylneuraminic acid, Disaccharides; concept of Reducing and Non-reducing sugars, occurrence and Haworth projections of Maltose, Lactose, and Sucrose, Polysaccharides, storage polysaccharides, Starch and Glycogen. Structural Polysaccharides, Cellulose, Peptidoglycan and Chitin.

**Unit 3 Lipids** **No. of Hours: 10**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification of structural Lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of Phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of Sphingosine, Ceramide. Special mention of Sphingomyelins, Cerebrosides and Gangliosides. Derived lipids-structure and function of Cholesterol. Lipid functions: Cell signals, co-factors, Prostaglandins, Introduction of Lipid micelles, Monolayers, Bilayers.

**Unit 4 Proteins** **No. of Hours: 9**

Functions of Proteins, Primary structures of proteins: Amino acids, the building blocks of Proteins. General formula of Amino Acid and concept of Zwitterion, Classification, biochemical structure and notation of standard protein Amino Acids Ninhydrin reaction. Natural modifications of amino acids in proteins Hydrolysine, Cystine and Hydroxyproline, Non-protein aminoacids: Gramicidin, Beta-alanine,D-

alanine and D-glutamic acid. Oligopeptides: Structure and functions of naturally occurring Glutathione and Insulin and synthetic Aspartame, Secondary structure of Proteins: Tertiary and Quaternary. Structure of proteins. Forces holding the Polypeptide together. Human Haemoglobin structure, Quaternary structures of Proteins.

**Unit 5 Enzymes** **No. of Hours: 10**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: Active site, transition state complex and Activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Km, and Allosteric mechanism. Definitions of terms – Enzyme unit, specific activity and Turnover number, Multienzyme complex: Pyruvate dehydrogenase; Isozyme: Lactate dehydrogenase, Effect of pH and temperature on Enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts. Enzyme Regulation.

**Unit 6 Vitamins** **No. of Hours: 3**

Classification and characteristics with suitable examples, sources and importance

**MJ-301P: BIOCHEMISTRY (PRACTICALS) SEMESTER –III**

**TOTALHOURS: 30** **CREDITS: 1**

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts.
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant.
3. Standard Free Energy Change of coupled reactions.
4. Qualitative/Quantitative tests for Carbohydrates, Reducing sugars, non-reducing sugars.
5. Qualitative/Quantitative tests for Lipids and Proteins.
6. Study of Protein secondary and tertiary structures with the help of models.

## SUGGESTED READING


1. Campbell, M K(2012)Biochemistry,7th ed., Published by Cengage Learning.
2. Campbell, P N and Smith A D (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.
3. Tymoczko J L, Berg J M and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman.
4. Berg J M, Tymoczko J L and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
5. Nelson D L and Cox M M (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Willey M J, Sherwood, L M & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by 9th Ed., McGraw Hill.
7. Voet, D and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

## B.Sc. MICROBIOLOGY SEMESTER –III

**MJ-302T: VIROLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** Students have-

**Outcome 1.** Understood what are viruses and chemical nature of viruses, different types of viruses infecting animals, plants and bacteria (bacteriophage).

**Outcome 2.** Understanding about the biology of bacteriophages.

**Outcome 3.** Gained knowledge of a variety of plant viruses and animal viruses.

**Outcome 4.** The ability to describe role of viruses in the causation of the cancer.

**Unit 1 Nature and Properties of Viruses** **No. of Hours: 10**

Introduction: Discovery of Virus, nature and definition of viruses, general properties, concept of Viroids, Virusoids, Satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, Enveloped and Non-enveloped viruses. Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.

**Unit 2 Bacteriophages** **No. of Hours**: **10**

Diversity, Classification, one step multiplication curve, Lytic and Lysogenic phages

(Lambda phage) concept of early and late proteins, stages of infection, regulation of transcription in Lambda Phage.

**Unit 3 Viral Transmission, Salient features of viral nucleic acids & Replication No. of Hours: 15**

Modes of viral transmission: Persistent, non-persistent, Vertical and Horizontal

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

**Unit 4 Viruses and Cancer No. of Hours: 6**

Introduction to Oncogenic viruses

Types of Oncogenic DNA and RNA viruses: Concepts of Oncogenes and Proto-oncogenes. Conversion of Proto-oncogenes into Oncogenes.

**Unit 5 Prevention & control of Viral diseases No. of Hours: 5**

Antiviral compounds and their mode of action. Interferons and their mode of action

General principles of viral vaccination.

**Unit 6 Applications of Virology No. of Hours: 4**

Use of Viral vectors in Cloning and expression, Gene therapy- types and applications, Phage display.

**MJ-302P: VIROLOGY (PRACTICAL) SEMESTER –III**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Study of the structure of important Animal viruses (Rhabdo, Influenza, Paramyxo Hepatitis B and Retroviruses) using Electron micrographs.
2. Study of the structure of important Plant Viruses (Caulimo, Gemini, Tobacco ring spot, Cucumber mosaic and Alpha-alpha mosaic viruses) using Electron micrographs.
3. Study of the structure of important Bacterial viruses (ϕX174, T4, λ) using Electron micrograph.
4. Isolation and Enumeration of Bacteriophages (PFU) from water/sewage sample using double Agar layer technique.
5. Studying isolation and propagation of Animal viruses by Chick embryo technique.
6. Study of Cytopathic effects of viruses using photographs.
7. Perform local lesion technique for assaying Plant viruses.

**SUGGESTED READING**


1. Dimmock, N J, Easton, A L, Leppard, K N (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint S J, Enquist, L W, Krug, R M, Racaniello, V R, Skalka, A M (2004). Principles of Virology, Molecular Biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy J A, Conrat H F, Owens R A (2000). Virology 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner E K, Hew let M J (2004). Basic Virology 2nd edition. Blackwell Publishing.
6. Mathews (2004) Plant Virology. Hull R. Academic Press, New York.
7. Nayudu M V (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L (1999) Plant viruses- A textbook of Plant Virology by Back huys Publishers.
9. Versteeg J (1985). A Color Atlas of Virology. Wolfe Medical Publication.

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER–IV**

**MJ-401T: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** By the conclusion of this course, students are capable of-

**Outcome 1.** Describing the growth characteristics of the microorganisms capable of growing under unusual environmental condition of temperature, oxygen, solute and water activity.

**Outcome 2.** Describing the growth characteristics of the microorganisms which require different nutrient for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemolithotrophs etc.

**Outcome 3.** Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.

**Unit 1 Microbial Growth and Effect of Environment on Microbial Growth**

**No. of Hours: 10**

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–Autotrophs/Phototrophs, Heterotrophs, Chemolithoautotrophs, Chemolithoheterotrophs, Chemoheterotrophs, Chemolithotrophs, Photolithoautotrophs, Photoorganoheterotrophs.

**Unit 2 Nutrient uptake and Transport No. of Hours: 5**

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: 10**

Concept of Aerobic respiration, Anaerobic respiration and Fermentation Sugar degradation pathway 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: 5**

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.

**Unit 6 Nitrogen Metabolism-An overview** **No. of Hours: 5**

Introduction to Biological Nitrogen fixation, Ammonia assimilation, Assimilatory Nitrate reduction, Dissimilatory Nitrate reduction, Denitrification.

## MJ-401P: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)

**SEMESTER–IV**

**TOTAL HOURS: 30** **CREDITS: 1**

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.

## SUGGESTED READINGS


1. Madigan M T, and Martinko J M (2014). Brock Biology of Microorganisms.14th edition. Prentice Hall International Inc.
2. Moat A G and Foster J W (2002). Microbial Physiology 4th edition. John Wiley & Sons.
3. Reddy S R and Reddy S M (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
6. Stanier R Y, Ingrahm J I, Wheelis M L and Painter P R (1987). General Microbiology 5th edition, Mc Millan Press.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER – IV

**MJ-402T: CELL BIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** By the end of this paper the students will be able to understand-

**Outcome 1.** The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.

**Outcome 2.** How these cellular components are used to generate and utilize energy in cells.

**Outcome 3.** They will understand the cellular components underlying mitotic cell division.

**Outcome 4.** The regulation of cell cycle and about signaling molecules and their receptors.

**Unit 1 Structure and organization of Cell** **No. of Hours: 12**

Cell Organization– Eukaryotic (Plant and animal cells) and prokaryotic, Plasma membrane: Structure, Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions-adhesion junctions, tight junctions, gap junctions, and Plasmodesmata (only structural aspects)

Mitochondria, Chloroplasts and Peroxisomes, Cytoskeleton: Structure and organization of Actin filaments, association of Actin filaments with Plasma membrane, cell surface protrusions, intermediate filaments, Microtubules.

**Unit 2 Nucleus** **No. of Hours: 4**

Nuclear envelope and nuclear matrix, nuclear pore complex and nuclear lamina Chromatin – Molecular organization, Nucleolus, transport through nuclear pore.

**Unit 3 Protein Sorting and Transport** **No. of Hours: 11**

Ribosomes, Endoplasmic Reticulum–Structure, targeting and insertion of proteins in the ER, Protein folding, processing and quality control in ER, N-linked Glycosylation of Protein, smooth ER and lipid membrane synthesis, export of proteins and Lipids, Golgi Apparatus–Organization, Protein glycosylation, protein sorting and export from Endoplasmic Reticulum to Golgi Apparatus to Lysosomes.

**Unit 4 Cell Signaling** **No. of Hours: 8**

Signaling molecules and their receptors. Function of cell surface receptors
Pathways of intra-cellular receptors– Cyclic AMP pathway, cyclic GMP, MAP kinase pathway and GPCR mediated pathway.

**Unit 5 Cell Cycle, Cell Death and Cell Renewal** **No. of Hours: 10**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types, Programmed cell death, Stem cells, Embryonic stem cell, induced pluripotent stem cells.

**MJ-402P: CELL BIOLOGY (PRACTICAL) SEMESTER –IV**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs.
3. Cytochemical staining of DNA –Feulgen.
4. Demonstration of the presence of mitochondria instriated muscle cells/cheek

epithelial cell using vital stain Janus Green B.

5. Study of polyploidy in Onion root tip by colchicines treatment.

6. Identification and study of cancer cells by photomicrographs.

7. Study of different stages of Mitosis.

8. Study of different stages of Meiosis.

**SUGGESTED READING**

1. Hardin J, Bertoni G and Kleinsmith L J (2010). Becker's World of the Cell 8th edition. Pearson.

2. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6thedition. John Wiley & Sons Inc.

3. De Robertis, EDP and De Robertis EMF (2006). Cell and Molecular Biology 8th edition. Lipincott Williams and Wilkins, Philadelphia.

4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach 5th Edition. ASM Press & Sunderland, Washington, D.C.;Sinauer Associates, MA.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER – IV

**MJ-403T: MOLECULAR BIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** By the end of this paper the students will be able to understand-

**Outcome 1.** Understand the chemical and molecular processes that occur in and between cells.

**Outcome 2.** Provide comprehensive background of salient features of Nucleic acids and DNA model.

**Outcome 3.** To give detailed explanation of Transcriptional regulation, post transccriptional modifications and processing of Eukaryotic RNA to the students.

**Outcome 4.** The process of protein synthesis along with the role of all the players participating in the process. The fidelity of translation will also be understood.

**Unit 1 Structures of DNA and RNA/Genetic Material** **No. of Hours: 8**

DNA Structure: Miescher to Watson and Crick- historic perspective, Griffith's experiment to prove DNA as genetic material, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, Denaturation and Renaturation, cot curves. DNA topology- linking number, Topoisomerase;

Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA—mitochondria and chloroplast DNA.

**Unit 2 Replication of DNA (Prokaryotes and Eukaryotes**) **No. of Hours: 8**

Model of DNA replication**,** Messelson and Stahl experiment**,** Bidirectional and unidirectional replication, replication fork, Replicon and origin of Replication, semi-conservative, Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, Primase, Telomerase–for replication of linear ends.

Various modes of DNA replication including rolling circle, D-loop (mitochondrial), Θ(theta) mode of replication and other accessory protein, DNA repair, Mismatch and Excision repair, repair of DS break, SOS response, DNA recombination.

**Unit 3 Transcription in Prokaryotes and Eukaryotes No. of Hours: 7**

Transcription: Definition, difference from replication, promoter-concept and strength of promoter RNA polymerase and the transcription unit. Stages of prokaryotic transcription, Transcription in Eukaryotes: RNA polymerases, general Transcription factors.

**Unit 4 Post-Transcriptional Processing No. of Hours: 7**

Split genes, Concept of Introns and Exons, RNA splicing, Spliceosome machinery**,** concept of alternative splicing, Polyadenylation and Capping, Processing of rRNA, RNA interference: siRNA, miRNA, Sn RNA and its significance.

**Unit 5 Translation (Prokaryotes and Eukaryotes) No. of Hours: 7**

Translational machinery, Charging of tRNA, Aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both Prokaryotes and Eukaryotes, Fidelity of Translation, Inhibitors of Protein synthesis in Prokaryotes and Eukaryotes.

**Unit 6 Regulation of Gene Expression in Prokaryotes and Eukaryotes**

**No. of Hours: 8**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus,* Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone acetylation mechanisms.

**MJ-403P: MOLECULAR BIOLOGY (PRACTICAL) SEMESTER–IV**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Study of different types of DNA and RNA using micrographs and model/schematic representations.
2. Study of semi-conservative replication of DNA through micrographs/schematic representations.
3. Isolation of genomic DNA from *E.coli.*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenyl amine reagent) or UV spectrophotometer (A260 measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

**SUGGESTED READINGS**


1. Watson J D, Baker T A, Bell S P, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
2. Becker W M, Kleinsmith L J, Hardin J and Bertoni G P (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco.
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

5. Sambrook J and Russell D W (2001). Molecular Cloning: A Laboratory Manual 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013).Lewin's Essential Genes, 3rdEd., Jones and Bartlett Learning.
7. Gardner E J, Simmons M J, Snustad D P (2008). Principles of Genetics 8th Ed.Wiley-India.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER-V

**MJ-501T: INHERITANCE BIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** By the conclusion of this course, the students have –

**Outcome 1.** Developed perception of evolution taking examples from well-studied models organisms of bacteria, fungi and other organisms.

**Outcome 2.** Good understanding of concepts of Mendelian genetics and structural organizations of chromosomes.

**Outcome 3.** Developed practical skills to do karyotyping and pedigree analysis.

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

Historical developments. Model organisms in genetic analysis and experimentation: *Escherichia coli, Saccharomyces cerevisiae, Neurosporacrassa, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana*.

**Unit 2 Mendelian Principles** **No. of Hours: 7**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, Pseudoallele, complementation tests, Extensions

of Mendelian genetics: Allelic interactions, concept of dominance, Recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.

**Unit 3 Linkage and Crossing over** **No. of Hours: 6**

Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping.

**Unit 4 Extra-Chromosomal Inheritance** **No. of Hours: 9**

Rules of extra nuclear inheritance, Organelle heredity-Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects–Shell coiling in *Limnae aperegra*, Infectious heredity, Kappa particles in *Paramecium*.

**Unit 5 Characteristics of Chromosomes** **No. of Hours: 10**

Structural organization of chromosomes - Centromeres, Telomeres and repetitive DNA, Packaging DNA molecules into Chromosomes, Concept of Euchromatin and Heterochromatin, Normal and abnormal Karyotypes of human Chromosomes, Chromosome banding, Giant Chromosomes: Polytene and Lampbrush Chromosomes, Variations in Chromosome structure: Deletion, Duplication, Inversion and Translocation, Variation in chromosomal number and structural abnormalities- Klinefelter syndrome, Turner syndrome, Down syndrome.

**Unit 6 Recombination** **No. of Hours: 3**

Homologous and non-homologous recombination, including transposition, site-specific recombination.

**Unit 7 Human genetics** **No. of Hours: 3**

Pedigree analysis, LOD score for linkage testing, Karyotypes, Genetic disorders.

**Unit 8 Quantitative genetics** **No. of Hours: 3**

Polygenic inheritance, heritability and its measurements, QTL mapping.

**MJ-501P: INHERITANCE BIOLOGY (PRACTICAL) SEMESTER–V**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Mendelian deviations in Dihybrid crosses.
2. Studying Barr Body with the temporary mount of Human Cheek cells.
3. Studying *Rhoeo* translocation with the help of photographs.
4. Karyotyping with the help of photographs.
5. Chi-Square Analysis.
6. Study of Polytene chromosomes using temporary mounts of salivary glands of *Chiromonas/Drosophila* larvae.
7. Study of Pedigree Analysis.
8. Analysis of a representative quantitative trait.

**SUGGESTED READING**


1. Gardner E J, Simmons M J, Snustad D P (2008). Principles of Genetics 8th Ed. Wiley-India.
2. Snustad D P, Simmons M J (2011). Principles of Genetics. 6thEd. John Wiley and Sons Inc.
3. Weaver R F, Hedrick P W (1997). Genetics. 3rd Ed. McGraw-Hill Education.
4. Klug W S, Cummings M R, Spencer C A, Palladino M (2012). Concepts of Genetics 10th Ed. Benjamin Cummings.
5. Griffith A J F, Wessler S R, Lewontin R C, Carroll S B. (2007). Introduction to Genetic Analysis. 9th Ed. W. H. Freeman and Co., New York.
6. Hartl D L, Jones E W (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers.
7. Russell P J. (2009). Genetics-A Molecular Approach. 3rd Ed, Benjamin Cummings.

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER –V**

**MJ-502T: PLANT PATHOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES** : By the conclusion of this course, the students-

**Outcome 1.** Developed basic concepts of causation of diseases in plants by the different types of microorganisms namely bacterial, fungal and viral.

**Outcome 2.** Knowledge of important plant diseases, their etiology, salient characteristics and control measures.

**Outcome 3.** Developed skills to analyze the diseased plant samples in the laboratory and are able to identify the salient features of the disease-causing microbe and the lesions produced on the plant parts.

**Unit 1 Introduction and History of Plant Pathology** **No. of Hours: 5**

Concept of Plant disease- Definition 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 eminent 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: 12**

A. *Microbial Pathogenicity*

Virulence factors of pathogens: Enzymes, Toxins (host specific and nonspecific) 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 corklayer, abscission layer, tyloses, gums), inducible biochemical defenses hypersensitive response (HR), systemic acquired resistance (SAR), Phytoalexins, Pathogenesis related (PR) proteins, Plant bodies, 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 protectant Sand systemic Fungicides, Antibiotics, Resistance of Pathogens to chemicals. Biological- suppressive oils, 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: 11**

Study of some important Plant Diseases giving emphasis on its Etiological agents, Symptoms, Epidemiology and Control

*A.* Important diseases caused by fungi White rust of crucifers-*Albugo candida*

Late blight of potato –*Phytophthora infestans* Ergot of rye –*Claviceps purpurea*

Black stem rust of wheat –*Puccinia graministritici.*

Loose smut of wheat –*Ustilagonuda.*

Wilt of tomato –*Fusarium oxysporum*sp. *lycopersici.*

Red rot of sugarcane –*Colletotrichum falcatum.*

Early blight of potato –*Alternaria solani.*

B. Important diseases caused by Phytopathogenic bacteria: Crown galls, Bacterial cankers of citrus.

C. Important diseases caused by Phytoplasmas: Aster Yellow, Citrus stubborn.

D. Important diseases caused by viruses: Papaya ringspot, banana bunchy top, rice tungro.

E. Important diseases caused by Viroids: Potato spindle tuber.

**MJ-502P: PLANT PATHOLOGY (PRACTICAL) SEMESTER–V**

**TOTAL HOURS: 30** **CREDITS: 1**

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.*

**SUGGESTED READINGS**

1. Agrios G N. (2006). Plant Pathology. 5th edition. Academic press, San Diego,

2. Lucas J A. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Black well Science, Oxford.

3. Mehrotra R S. (1994). Plant Pathology. Tata McGraw-Hill Limited.

4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.

5. Singh R S. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER–V

## MJ-503T: ENVIRONMENTAL MICROBIOLOGY (THEORY)

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES** : By the completion of this course, the students –

**Outcome 1.** Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut.

**Outcome 2.** Are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes; how these activities of microorganisms are used in sewage treatment plants, production of activated sludge and functioning of septic tanks.

**Outcome 3**.Have understood the significance of BOD/COD and various tests involving use of enumerating fecal E.coli for assessing quality of water.

**Outcome 4.** Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation; practically assess the portability of drinking water by the use of standard microbiological tests.

**Unit 1 Microorganisms and their Habitats** **No. of Hours: 9**

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. Microbial succession in Decomposition of Plant Organic matter.

**Unit 2 Microbial Interactions** **No. of Hours: 9**

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: 9**

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: 9**

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 treatments.

**Unit 5 Microbial Bioremediation** **No. of Hours: 5**

Principles and degradation of common Pesticides, Organic (Hydrocarbons, Oil-spills) and Inorganic (metals) matter, Biosurfactants.

**Unit 6 Water Potability** **No. of Hours: 4**

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

**MJ-503P: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)**

**SEMESTER –V**

**TOTALHOURS: 30** **CREDITS: 1**

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.

**SUGGESTED READINGS**

1. Atlas R M and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

2. Madigan M T, Martinko J M and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings.

3. Maier R M, Pepper I L and Gerba C P. (2009). Environmental Microbiology. 2nd edition, Academic Press

4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York

5. Singh A, Kuhad, R C & Ward O P (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

6. Barton L L & Northup D E (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell R E. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne M S. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch J M & Hobbie J E. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao N S. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey J M, Sherwood L M, and Woolverton C J. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER–VI

**MJ-601T: FOOD AND DAIRY MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Are able to describe the role of microorganisms in the production of food, its spoilage, including their role homemade fermented foods.

**Outcome 2.** Are able to identify the role of microorganisms in the causation of the diseases and how to protect against food-borne pathogens.

**Outcome 3.** Developed experimental skill for testing milk and different foods for the presence of microorganisms.

**Unit 1 Foods as a substrate for microorganisms** **No. of Hours: 4**

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:7**

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

**Unit 3 Principle and methods of food preservations** **No. of Hours: 9**

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

**Unit 4 Fermented foods** **No. of Hours: 9**

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:9**

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:3**

HACCP, Indices of food sanitary quality and sanitizers

**Unit 7 Cultural and rapid detection methods of foodborne pathogens in food sand introduction to predictive microbiology.** **No. of Hours:4**

**MJ-601P: FOOD AND DAIRY MICROBIOLOGY (PRACTICAL)**

**SEMESTER–VI**

**TOTAL HOURS: 30** **CREDITS:1**

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.

**SUGGESTED READINGS**


1. Adams M R and Moss M O. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart J M. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson P M and Brannen A L. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. DillionV M and Board R G. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Walling ford, Oxon.
5. Frazier W C and Westhoff D C. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould G W. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay J M, Loessner M J and Golden D A. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund B M, Baird Parker A C, and Gould G W. (2000). The Microbiological Safety and Qualityof Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora G J, Funke B R, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER –VI

**MJ-602T: MICROBIAL GENETICS (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Understood the molecular mechanisms that underlie mutations.

**Outcome 2.** Developed a very fairly good knowledge about the three well known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation.

**Outcome 3.** Are able to describe different types of extra-chromosomal elements or the plasmids; the nature of the transposable elements in the prokaryotic and eukaryotic cells.

**Outcome 4.** Hands on skills of isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis.

**Unit 1 Mutations** **No. of Hours: 10**

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

**Unit 2 Plasmids** **No. of Hours: 10**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2μ 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: 10**

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 and Mapping by recombination

**Unit 4 Phage Genetics** **No. of Hours:5**

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

**Unit 5 Transposable elements** **No. of Hours:10**

Prokaryotic transposable elements–Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Eukaryotic transposable elements-Yeast (Tyretrotransposon), Drosophila (Pelements), Maize (Ac/Ds). Uses of transposons and transposition

**MJ-602P: MICROBIAL GENETICS (PRACTICAL) SEMESTER–VI**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Preparation of Master and Replica Plates
2. Study the effect of chemical ($HNO_2$) 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

## SUGGESTED READING


1. Klug W S, Cummings M R, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce B A (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson J D, Baker T A, Bell S Petal. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner E J, Simmons M J, Snustad D P (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell P J. (2009). Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell D W. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy S R, Cronan J E and Friefelder D (2004) Microbial Genetics 2nd edition., Jones and Barlett Publishers

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER –VI**

**MJ-603T: IMMUNOLOGY (THEORY)**

**TOTAL HOURS:45** **CREDITS:3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Conceptualized the protective role of the immune system of the host.

**Outcome 2.** Understanding the basic components as well as the mechanisms underlying the immune system and its response to pathogenic microorganisms.

**Outcome 3.** Are able to conduct experiments for growing common bacteria in different microbiological media, antibiotic sensitivity determination and antigen antibody reaction (precipitation test in the agarose).

**Unit 1 Introduction** **No. of Hours:3**

Concept of Innate and Adaptive immunity; Contributions of following scientistst of 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: 4**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK

cell,

Macrophage,Neutrophil,Eosinophil,Basophil,Mastcell,Dendriticcell;andImmuneOrgans–Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT,CALT

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

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:4**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); action of antibodies, V D J rearrangements; Monoclonal, hybridoma technology, Chimeric antibodies

**Unit 5 Major Histocompatibility Complex** **No. of Hours:4**

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

**Unit 6 Complement System** **No. of Hours:3**

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:8**

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: 8**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies -

Animal models (Nude and SCID mice), SCID, Di George syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

**Unit 9 Immunological Techniques** **No.ofHours:8**

Principles of Precipitation, Agglutination, Immunodiffusion, Immuno electrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flowcytometry, Immunoelectron microscopy.

**MJ-603P: IMMUNOLOGY (PRACTICAL) SEMESTER –VI**

**TOTALHOURS:30** **CREDITS:1**

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 immune diffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immune electrophoresis.

**SUGGESTED READINGS**


1. Abbas A K, Lichtman A H, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt I M. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Golds by R A, Kindt T J, Osborne B A. (2007). Kuby's Immunology. 6th edition W. H. Freeman and Company, New York.
4. MurphyK, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER–VI**

**MJ-604T: MEDICAL MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Developed a fair understanding of normal microflora of the human body and host pathogen interaction.

**Outcome 2.** Understood the basic and general concepts of causation of disease by the pathogenic microorganism and the various parameters of assessment of their severity including the broad categorization of the methods of diagnosis.

**Outcome 3.** Developed a thorough understanding of common bacterial, viral, fungal, parasitic diseases of human being.

**Outcome 4.** Are able to perform different diagnostic tests like ELISA AND agglutination based tests.

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

**No. of Hours: 7**

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: 9**

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 influenza, 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: 9**

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 swineflu, Ebola, Chikungunya, Japanese Encephalitis

**Unit 5 Protozoa and Diseases** **No. of Hours: 4**

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: 4**

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'sfoot) Systemic mycoses: Histoplasmosis

Opportunistic mycoses: Candidiasis

**Unit 7Antimicrobial agents: General characteristics and mode of action**

**No. of Hours: 7**

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

**MJ-604P: MEDICAL MICROBIOLOGY (PRACTICAL) SEMESTER–VI**

**TOTALHOURS: 30 CREDITS: 1**

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

**SUGGESTED READING**

1. Ananthanarayan R. and Paniker C. K. J. (2009) Textbook of Microbiology. 8th edition, University Press Publication

2. Brooks G. F., Carroll K. C., Butel J. S., Morse S. A. and Mietzner, T. A. (2013)

Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier

4. Willey J M, Sherwood L M, and Woolverton C J. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

5. Madigan M T, Martinko J M, Dunlap P V and Clark D P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER –VII

**MJ-701T: BIOINFORMATICS (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Developed skills to use computers for analysis of biological data.

**Outcome 2.** Skill to use important biological databases, use tools to retrieve data and compare the data of biological macromolecules.

**Outcome 3.** Developed basic skills for data retrieval, representation, analysis and interpretation.

**Unit 1Introduction to Computer Fundamentals** **No. of Hours: 3**

RDBMS - Definition of relational database Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

**Unit 2 Introduction to Bioinformatics and Biological Databases**

**No. of Hours: 10**

Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage-File formats- FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI,

EMBL, DDBJ, Uniprot, PDB

**Unit 3 Sequence Alignments, Phylogeny and Phylogenetic trees No. of Hours:12**

Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring analignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction- UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood

**Unit 4 Genome organization and analysis No. of Hours: 10**

Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes, Genome, transcriptome, proteome, Sequencing genomes - sequence assembly - genome on the web - annotating and analysing genome sequences. Proteomics - biochemical pathway databases.

**Unit 5 Protein Structure Predictions No. of Hours: 10**

Hierarchy of protein structure- primary, secondary and tertiary structures, modeling Structural Classes, Motifs, Folds and Domains Protein structure prediction in presence and absence of structure template. Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design

**MJ-701P: BIOINFORMATICS (PRACTICAL) SEMESTER –VII**

**TOTAL HOURS: 30 CREDITS:1**

1. Introduction to different operating systems - UNIX, LINUX and Windows
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB
3. Sequence retrieval using BLAST
4. Sequence alignment & phylogenetic analysis using clustal W & phylip
5. Picking out a given gene from genomes using Genscan or other softwares (promoter region identification, repeating enome, ORF prediction). Gene finding tools

(Glimmer, GENSCAN), Primer designing, Genscan/Genetool

6. Protein structure prediction: primary structure analysis, secondary structure prediction using psi- pred, homology modeling using Swiss model. Molecular visualization using jmol, Protein structure model evaluation (PROCHECK)

7. Prediction of different features of a functional gene

**SUGGESTED READING**


1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House

2. Pradeep and Sinha Preeti (2007). Foundations of Computing, 4th ed., B P B Publications

3. Lesk M. A. (2008) Introduction to Bioinformatics. Oxford Publication, 3rd International Student Edition

4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007). Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication

5. Primrose and Twyman (2003). Principles of Genome Analysis & Genomics. Blackwell

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER–VII**

**MJ-702T: RECOMBINANT DNA TECHNOLOGY (THEORY)**

**TOTAL HOURS: 45 CREDITS: 3**

**Time: 3 Hours Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Understood the basic and general concepts of genetic engineering as well as tools and strategies used for molecular cloning.

**Outcome 2.** Developed a fair understanding of various methods of delivering foreign DNA into any host cell.

**Outcome 3.** Developed a thorough understanding of DNA amplification, DNA sequencing and cDNA library preparation.

**Outcome 4.** Are able to perform DNA digestion and bacterial transformation by preparing competent cells.

**Unit 1 Introduction to Genetic Engineering No. of Hours:1**

Milestones in genetic engineering and biotechnology

**Unit 2 Molecular Cloning-Tools and Strategies No. of Hours: 10**

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering

DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs. Use of linkers and adaptors. Expression vectors: *E.coli*, yeastYIp, YEp mammalian SV40-based expression vectors

**Unit 3 Methods in Molecular Cloning** **No. of Hours:12**

Transformation of DNA: Chemical method, Electroporation, Genedelivery: Microinjection, electroporation, biolistic method (genegun), liposome and viral-mediated delivery, *Agrobacterium* – mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern- and Northern-blotting techniques, dotblot, DNA microarray analysis, SDS-PAGE and Western blotting.

**Unit 4 DNA Amplification and DNA sequencing** **No. of Hours:10**

PCR: Basics of PCR, types of PCR –RT-PCR, Real-Time PCR, RACE, Sanger's method of DNA Sequencing: Chain termination, chemical degradation and automated sequencing, Primer walking and shotgun sequencing, Genome mapping

**Unit 5 Construction and Screening of Genomic and cDNA libraries**

**No. of Hours: 6**

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

**Unit 6 Applications of Recombinant DNA Technology** **No. of Hours:6**

Products of recombinant DNA technology: Products of human therapeutic interest-insulin, hGH, antisense molecules. Transgenic plants-Bt transgenic - cotton, brinjal, transgenic animals, Gene therapy, recombinant vaccines, protein engineering, site directed mutagenesis, nuclear transfer technology and animal cloning, DNA profiling

**MJ-702P: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)**
**SEMESTER–VII**

**TOTALHOURS: 30** **CREDITS: 1**

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

**SUGGESTED READING**


1. Brown T A. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark D P and Pazdernik N J. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose S B and Twyman R M. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley J M, Sherwood L M and Woolverton C J. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Scienc Publishers
7. Primrose S B and Twyman R M. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER–VII**

**MJ-703T: INDUSTRIAL MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Are capable of describing a large number of substrate that are used for the industrial fermentation processes.

**Outcome 2.** Have developed an understanding of different types of reactors of fermenters which are used for laboratory, pilot and industrial scale fermentations and their processes parameters.

**Outcome 3.** Have acquired a detailed knowledge of number of products which are produced by industrial fermentation processes.

**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: 12**

Sources of industrially important microbes and methods for their isolation,

preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn- steep 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: 11**

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: 10**

Citric acid, ethanol, penicillin, glutamic acid, VitaminB12, Enzymes (amylase, protease, lipase) Wine, beer

**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 penicillinacylase)

**MJ-703P: INDUSTRIAL MICROBIOLOGY (PRACTICAL) SEMESTER –VII**

**TOTALHOURS: 30** **CREDITS: 1**

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.

**SUGGESTED READINGS**


1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M. J., Morgan N. L., Rockey J. S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition.
4. Wiley –Blackwell Glaze N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition.
5. W.H. Freeman and Company Casida L E. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury P F, Whitaker A and Hall S J. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

## B.Sc. (HONOURS) MICROBIOLOGY SEMESTER –VII

**MJ-704T: ANALYTICAL TECHNIQUES (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Developed understanding of principles and applications of different microscopic and spectrophotometric methods.

**Outcome 2.** Developed understanding of principles and applications of different separation techniques especially chromatographic, electrophoretic and centrifugation techniques.

**Outcome 3.** Skills in handling and use of light microscope, spectrophotometer and centrifugation equipment to study/analyze various microbiological samples.

**Unit 1 Biophysical Technique** **No. of Hours: 10**

Microchip, Biosensor, SAGE, RFLP, RAPD, AFLP, CRISPR-Cas Technology

**Unit 2 Chromatography** **No. of Hours: 10**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion- exchange chromatography and affinity chromatography, GLC, HPLC.

**Unit 3 Electrophoresis** **No. of Hours: 9**

Principle and applications of native polyacrylamide gel electrophoresis, SDS-polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric-focusing, Zymogram preparation and Agarose gel electrophoresis.

**Unit 4 Spectrophotometry** **No. of Hours: 9**

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry, NMR and mass spectrometry.

**Unit 5 Centrifugation** **No. of Hours: 7**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

**MJ-704P: ANALYTICAL TECHNIQUES (PRACTICAL) SEMESTER–VII**

**TOTALHOURS: 30** **CREDITS: 1**

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography
6. Determination of $\lambda_{max}$ for an unknown sample and calculation of extinction coefficient.
7. Separation of components of a given mixture using a laboratory scale centrifuge.
8. Understanding density gradient centrifugation with the help of pictures

**SUGGESTED READINGS**

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.

2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood L M & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, M A.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER –VIII

**MJ-801: BIOSTATISTICS (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed basic concepts of statistics and their importance as applied to biological phenomenon.

**Outcome 2.** Developed understanding of testing of hypothesis.

**Outcome 3.** Able to carry out calculations of various parameters used in statistical methods.

**Unit 1 Measures of central tendency** **No of Hours: 13**

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences;

**Unit 2 Mean and Variance** **No of Hours: 9**

Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;

**Unit 3 Statistical methods** **No of Hours: 10**

Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of

biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics;

**Unit 4 Sample and hypothesis testing** **No of Hours: 13**

Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom;

Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test;

Basic introduction to Multivariate statistics, etc.

**MJ-801P: BIOSTATISTICS (PRACTICAL) SEMESTER –VIII**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Mean, Median, Mode from grouped and ungrouped Data set
2. Standard Deviation and Coefficient of Variation
3. Skewness and Kurtosis
4. Curve fitting
5. Correlation
6. Regression
7. Finding area under the curve using normal probability
8. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test

**SUGGESTED READINGS**

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag,International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press;1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley andSons Inc; 2004.

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER –VIII

**AMJ-801T: BIOREMEDIATION (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Developed understanding of different types of pollutants.

**Outcome 2.** Understood the concepts of Microbial remediation, phytoremediation and the various processes involved in it.

**Outcome 3.** Skills in use of Microorganisms for degradation of pollutants.

**Unit-1 Types of pollution** **No. of hours: 7**

Definition of Bioremediation - Types of pollution - organic, inorganic in soil, water and air - Remediation by bacteria, fungi, microalgae and green plants.

**Unit -2 Microbial remediation** **No. of hours: 7**

Bioaccumulation and biomagnification processes - microbial remediation by natural attenuation - biostimulation - bioaugmentation.

**Unit -3 Immobilized microbes in soil decontamination** **No. of hours: 8**

Application of immobilized microbes in soil decontamination - use of genetically engineered microorganism and bioremediation.

**Unit -4 Biodegradation of organic compounds** **No. of hours: 10**

Biodegradation of organic compounds - humification and polymerization reaction - bio-transformation of metal and metal compounds - phyto -remediation use of microalgae, green plants to remove pollutants.

**Unit -5 Phytoremidiation** **No. of hours: 13**

Phyto-extraction - Types of phytoextraction - induced phyto-extraction and continuous phyto-extraction - phyto-degradation - rhizofiltration - phyto-stabilisation - phyto-volatisation of metals - phyto-remediation of organic. Bioavailability and uptake. Biotransformation and compartmentalisation.

**AMJ-801P: BIOREMEDIATION (PRACTICAL) SEMESTER –VIII**

**TOTAL HOURS: 30** **CREDITS: 1**

1.Degradation of para nitrophenol using *Pseudomonas putida*

2.Low density plastic/bioplastic degradation using bacterial isolates.

**SUGGESTED READINGS**

1. Moo-Young, M., Anderson, W.A. and Chakrabarty, A.M. 1996. Environmental biotechnology: Principles and applications. Boston, Mass.: Kluwer Academic Publishers.

2. Wainwright, M. 1999. An introduction to environmental biotechnology. Boston, Mass. Klumer Academic Publishers.

**B.Sc (HONOURS) MICROBIOLOGY SEMESTER –VIII**

**AMJ-802-T: MICROBIAL BIOTECHNOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Developed an understanding how microbiology if relevant to technological developments for agriculture and environment.

**Outcome 2.** Developed an understanding how microbiology if relevant to technological developments for industries related to food and fermentations.

**Outcome 3.** Developed an understanding how developments in recombinant DNA Technology is juxtaposed with microbial-based technological developments for agriculture, industry and environment.

**Unit 1 Microbial Biotechnology and its Applications** **No. of Hours: 8**

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: 8**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine).

Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors.

**Unit 3 Applications of Microbes in Biotransformations** **No. of Hours: 6**

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: 8**

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: 10**

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algalbiomass, Biogas production: Methane and hydrogen production using microbial culture.

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavymetals from aqueous effluents.

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

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

**Unit 6 Intellectual Property Rights** **No. of Hours: 1**

Patents, Copyrights, Trademarks.

**AMJ-802P: MICROBIAL BIOTECHNOLOGY (PRACTICAL)SEMESTER –VIII**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Study yeast cell immobilization in calcium alginate gels.
2. Study enzyme immobilization by calcium 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. Hydrolysis of Starch/Polysaccharide/Lignocellulosic residue.
7. Biotransformation of steroid and its detection by a suitable method (TLC).
8. Demonstration of production of a recombinant product.

**SUGGESTED READING**


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

**B.Sc. MICROBIOLOGY SEMESTER -VIII**

**AMJ-803T: AGRICULTURAL MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Developed a clear understanding of the multifarious role of microorganisms in soil, in association with plants and thus in the field of agriculture.

**Outcome 2.** Conceptualized the effects of agriculture on soil microbial communities.

**Outcome 3.** Are able to isolate and study various soil microorganisms having significant role in agro ecosystem.

**UNIT I. Soil Microorganism in agro ecosystem:** **No of hours: 10**

Types of microbial communities: soil microbial diversity: significance and conservation; effect of agricultural practices on soil organism.

**UNIT II. Biological Nitrogen fixation:** **No of hours: 11**

The range of nitrogen fixing organisms; mechanism of nitrogen fixation (biochemistry of nitrogenase); genetics of nitrogen fixation.

Rhizobiunm Legume Association; Symplasmids, $N_2$ fixation by non-leguminous plants.

**UNIT III. Chemical transformation of microbes:** **No of hours: 10**

Organic matter decomposition, nutrient mineralization and immobilization; transformation of carbon and carbon compounds.

**UNIT IV. Biofertilizers**: **No of hours: 4**

Mass cultivation of microbial inoculants; green manuring; algalization; *Azolla.*

**UNIT V. Microbial products and plant health**: **No of hours: 10**

Plant growth promoting rhizobacteria (PGPR); significance of mycorrhizae, Microbial herbicides, biological control. Biodegradation of herbicides and pesticides

**AMJ-803P: AGRICULTURAL MICROBIOLOGY (PRACTICAL) SEMESTER -VIII**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Isolation and enumeration of rhizosphere microorganisms
2. Isolation and enumeration of fungi from the soil sample
3. Isolation of actinomycetes from soil
4. Isolation of *Azotobacter* from the garden soil
5. Isolation of *Azospirillum* from the soil/root
6. Isolation of cyanobacteria from soil/water from paddy field
7. Isolation of phosphate solubilising microorganisms from the soil
8. Isolation of phosphate solubilising bacteria from soil sample

**SUGGESTED READING**

6. AnanthanarayanR.andPanikerC.K.J.(2009)TextbookofMicrobiology.8th edition,University PressPublication

7. BrooksG.F.,CarrollK.C.,ButelJ.S.,MorseS.A.andMietzner,T.A.(2013)Jawetz,Melnickand Adelberg's Medical Microbiology. 26th edition. McGraw HillPublication

8. GoeringR.,DockrellH.,ZuckermanM.andWakelinD.(2007)Mims'MedicalMicrobiology.4th edition. Elsevier

9. Willey JM, Sherwood LM, and Woolverton CJ.(2013) Prescott, Harley and Klein'sMicrobiology. 9th edition. McGraw Hill Higher Education

10. MadiganMT ,Martinko JM, Dunlap PV and ClarkDP .(2014).Brock Biology of Microorganisms. 14th edition. Pearson International Edition

**B.Sc. MICROBIOLOGY SEMESTER –I**

**MN-101T: INTRODUCTION AND SCOPE OF MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

## LEARNING OUTCOMES

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

**Outcome 2.** Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.

**Outcome 3.** Are able to explain the useful and harmful activities of the microorganisms.

**Outcome 4.** Are able to perform basic experiments to grow and study microorganisms in the laboratory.

**Unit 1 History of Development of Microbiology** **No. of Hours: 5**

Development of microbiology as a discipline, Spontaneous generation *vs.* biogenesis. Contributions ofAnton 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.WaksmanEstablishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

**Unit 2 Diversity of Microorganisms** **No. of Hours: 10**

Systems of classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility.

General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa) giving definitions and citing examples.

Protozoa: Methods of nutrition, locomotion & reproduction - Amoeba, *Paramecium* and *Plasmodium*.

**Unit 3 Microscopy** **No. of Hours: 5**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope,Transmission Electron Microscope, Scanning Electron Microscope.

**Unit 4 Sterilization** **No. of Hours: 5**

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filteration.

**Unit 3 Microbes in Human Health & Environment** **No. of Hours: 10**

**Medical microbiology and immunology**: List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondaryimmune response, antigen, antibody and their types.

**Environmental microbiology**: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (*e.g.* hydrocarbons in oil spills).

**Unit 4 Industrial Microbiology** **No. of Hours: 5**

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermentersand microbes producing important industrial products through fermentation.

**Unit 5 Food and Dairy Microbiology** **No. of Hours:5**

Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy basedfermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

**MN-101P: INTRODUCTION AND SCOPE OF MICROBIOLOGY (PRACTICALS)**

**SEMESTER –I**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Microbiology Laboratory Management 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 filtration and assessment for sterility.
7. Demonstration of presence of microflora in the environment by exposing nutrient agar platesto air.
8. Study of different shapes of bacteria using permanent slides.
9. Study of *Rhizopus, Penicillium, Aspergillus* using permanent mounts.
10. Study of *Spirogyra* and *Chlamydomonas* using permanent mounts.
11. Study of the following protozoans using permanent mounts/photographs: *Amoeba, Entamoeba, Paramecium* and *Plasmodium*.

**SUGGESTED READING**

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. PearsonEducation.

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

3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. PearsonEducation Limited.

4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGrawHill International.

5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.

6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGrawHill Book Company.

7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). GeneralMicrobiology. 5th edition. McMillan.

**B.Sc. MICROBIOLOGY SEMESTER – III**

**MN-301T: BACTERIOLOGY AND VIROLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have acquired a fairly good understanding of the different types of bacteria and viruses.

**Outcome 2.** Have developed a very good understanding of the structure of the structure and other salient characteristics of bacteria and viruses.

**Outcome 3.** Have acquired skills of visualizing bacteria by staining, using a microscope and culturing bacteria in microbiological media to describe the features of bacterial colonies.

**Unit 1 Cell organization** **No. of Hours: 8**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation.

**Unit 2 Bacterial growth and control** **No. of Hours: 7**

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media,selective media, differential media, enrichment culture media.

Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance andstocking of pure cultures, cultivation of anaerobic bacteria.

Growth: Binary fission, phases of growth.

**Unit 3 Bacterial Systematics and Taxonomy** **No. of Hours: 9**

Taxonomy, nomenclature, systematics, types of classifications.

Morphology, ecological significance and economic importance of the following groups: Archaea: methanogens, thermophiles and halophiles.

Eubacteria: Gram negative and Gram positive. Gram negative:

Non-proteobacteria– *Deinococcus, Chlamydia,* Spirochetes. Alpha proteobacteria- *Rickettsia, Rhizobium, Agrobacterium*. Gamma proteobacteria –*Escherichia,Shigella,Pseudomonas.*

Gram positive: Low G+C: *Mycoplasma, Bacillus, Clostridium, Staphylococcus* High G+C: *Streptomyces, Frankia*.

**Unit 4 Introduction to Viruses** **No. of Hours: 6**

Properties of viruses; general nature and important features. Subviral particles; viroids, prions and their importance.

Isolation and cultivation of viruses.

**Unit 5 Structure, and multiplication of viruses** **No. of Hours: 9**

Morphological characters: Capsid symmetry and different shapes of viruses with examples. Viral multiplication in the Cell: Lytic and lysogenic cycle.

Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitisviruses).

**Unit 6 Role of Viruses in Disease and its prevention** **No. of Hours: 6**

Viruses as pathogens: Role of viruses in causing diseases.

Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds.

**MN-301P: BACTERIOLOGY AND VIROLOGY (PRACTICAL)SEMESTER – III**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Preparation of different media: Nutrient agar, Nutrient broth.
2. To perform simple staining of the bacterial smear
3. To perform Gram's staining.
4. To perform spore staining.

5. Isolation of pure cultures of bacteria by streaking method.
6. Enumeration of colony forming units (CFU) count by spread plate method/pour plate.
7. Study the morphological structures of viruses (DNA and RNA) and their mportant characters using electron micrographs.
8. Study of the methods of isolation and propagation of plant viruses.
9. Study of cytopathic effects of viruses using photographs.

**SUGGESTED READING**


1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms. 14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons.
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology,Molecular Biology, Pathogenesis and Contro*l.*2nd edition.ASM Press.
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA.
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition PearsonEducation.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition,Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK.

**B.Sc MICROBIOLOGY SEMESTER –V**

**MN-501: INDUSTRIAL AND FOOD MICROBIOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have acquired a fairly good knowledge of how microbes are used in the fermentative production of organic acids, alcohols, enzymes, antibiotics and various foods in the industry.

**Outcome 2.** Have acquired knowledge of various physical parameters which affect production of industrial products by microorganisms and the safety aspects of the production and use of these products.

**Outcome 3.** Have developed laboratory skills in producing alcohol and enzymes by fermentative process using bacteria/yeast; Laboratory skills of testing microbial load in milk.

**Unit 1 Introduction to Industrial microbiology** **No. of Hours: 7**

Brief history and developments in industrial microbiology.

Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous.Types of fermenters – laboratory, pilot-scale and production fermenters.

Components of a typical continuously stirred tank bioreactor.

**Unit 2 Isolation of industrial strains and fermentation medium** **No. of Hours: 6**

Primary and secondary screening.

Preservation and maintenance of industrial strains.

Ingredients used in fermentation medium - molasses, corn steep liquor, whey &yeast extract.

**Unit 3 Microbial fermentation processes** **No. of Hours: 10**

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction. Microbial production of industrial products - citric acid, ethanol and penicillin.

Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases.

**Unit 4 Food as a substrate for microbial growth** **No. of Hours: 7**

Intrinsic and extrinsic parameters that affect microbial growth in food. Microbial spoilage of food - milk, egg, bread and canned foods.

**Unit 5 Principles and methods of food preservation and food sanitation** **No. of Hours: 7**

Physical methods - high temperature, low temperature, irradiation, aseptic packaging. Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite. Food sanitation and control – HACCP.

**Unit 6 Dairy products, probiotics and Food-borne Diseases** **No. of Hours: 8**

Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese. Probiotics definition, examples and benefits.

Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*. Food infection by *Salmonella* and *E.coli*.

**MN-501P: INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL) SEMESTER – V**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Microbial fermentation for the production and estimation of amylase.
2. Microbial fermentation for the production and estimation of citric acid.
3. Microbial fermentation for the production and estimation of ethanol.
4. Determination of the microbiological quality of milk sample by MBRT.
5. Isolation of fungi from spoilt bread/fruits/vegetables.
6. Preparation of yogurt.

**SUGGESTED READING**

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi.

2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India.

3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. PearsonEducation.

4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9$^{th}$Edition. McGraw Hill Higher education.

5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition,Elsevier Science Ltd.

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

8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.

9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7$^{th}$ edition, CBSPublishers and Distributors, Delhi, India.

**B.Sc MICROBIOLOGY SEMESTER –VII**

**MN-701T: MICROBES IN ENVIRONMENT (THEORY) SEMESTER – VII**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES** : By the completion of this course, the students –

**Outcome 1.** Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut.

**Outcome 2.** Are able to identify the important role microorganisms play in maintaining healthy environment by degradation of solid/liquid wastes; how these activities of microorganisms are used in sewage treatment plants, production of activated sludge and functioning of septic tanks.

**Outcome 3**.Have understood the significance of BOD/COD and various tests involving use of enumerating fecal E.coli for assessing quality of water.

**Outcome 4.** Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation; practically assess the portability of drinking water by the use of standard microbiological tests.

**Unit 1 Microorganisms and their Habitats** **No. of Hours: 10**

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.

**Unit 2 Microbial Interactions** **No. of Hours: 9**

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 luminescentbacteria.

**Unit 3 Biogeochemical Cycling** **No. of Hours: 8**

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: 8**

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: 5**

Principles and degradation of common pesticides, hydrocarbons (oil spills).

**Unit 7 Water Potability** **No. of Hours: 5**

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

**MN-701P: MICROBES IN ENVIRONMENT (PRACTICAL) SEMESTER –VII**

**TOTAL HOURS: 30** **CREDITS: 1**

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.

**SUGGESTED READINGS**

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

2.Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition.Pearson/ Benjamin Cummings

3.Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, AcademicPress

4.Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,New York

5.Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

6.Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

7.Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

8.Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

9.Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. NewYork & London.

10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,Cambridge, England.

11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**B.Sc. MICROBIOLOGY SEMESTER –II**

**MVC-201T: SOIL MICROBIOLOGY AND BIOFERTILIZER TECHNOLOGY (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Are able to describe the role of microorganisms in maintaining soil fertility and their importance in agriculture.

**Outcome 2.** Are able to identify the role of microorganisms in the biofertilization process.

**Outcome 3.** Have developed a good knowledge of different microorganisms used as biofertilizers.

**Outcome 4.** Are able to isolate different microorganisms important for production of biofertilizers.

**Unit 1: Soil microorganisms and biofertilizers** **No. of hours: 10**

Introduction to soil microorganisms – bacteria (cyanobacteria and actinobacteria), algae, fungi, protozoans, nematodes and viruses –Role of microbes in soil fertility. Microbial associations in phytosphere: rhizosphere – phyllosphere – spermosphere. Mycorrhiza –types and importance to agriculture – organic matter decomposition – humus formation.

Introduction to biofertilizers - Structure and characteristic features of the following biofertilizer organisms: Bacteria: *Azospirillum, Azotobacter, Bacillus, Pseudomonas,*

*Rhizobium and Frankia.* Cyanobacteria: *Anabaena, Nostoc*. Fungi: *Glomus, Gigaspora, Sclerocystis, Amanita, Laccaria.*

**Unit 2: Biofertilization and Nitrogen fixation** **No. of hours: 8**

Biofertilization processes - Decomposition of organic matter and soil fertility and vermicomposting. Mechanism of phosphate solubilization and phosphate mobilization.
Nitrogen fixation - Free living and symbiotic nitrogen fixation. Biotechnological application in nitrogen fixation.

**Unit 3: Biogeochemical cycles** **No. of hours: 7**

Biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur cycles; nitrogen fixers – root nodule formation – nitrogenase, hydrogenase – biochemistry of nitrogen fixation. Biofertilizers – definition, importance – types and their application methods – Steps in massproduction of bacterial biofertilizers – quality guidelines for biofertilizers. Mass production of blue green algae, Azolla and mycorrhiza. Plant response to biofertilizers application.

**Unit 4: Cynobacteria as biofertilizers** **No. of hours: 10**

Isolation and purification of Cyanobacteria. Mass multiplication of cyanobacterial bioinoculants - Trough or Tank method, Pit method, Field method; methods of application of cyanobacterial inoculum. Azolla - mass cultivation and application in rice fields.

**Unit 5: Fungi as biofertilizers** **No. of hours: 10**

Mycorrhizae - Ecto and endomycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications. Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer (Pseudomonas striata). Biofertilizers - Storage, shelf life, quality control and marketing.

**MVC-201P: SOIL MICROBIOLOGY AND BIOFERTILIZER TECHNOLOGY (PRACTICAL) SEMESTER –II**

**TOTAL HOURS: 30** **CREDITS: 1**

1.Determination of soil pH

2.Isolation and enumeration of rhizosphere microorganisms

3.Isolation and enumeration of fungi from the soil sample

4.Isolation of actinomycetes from soil

5.Isolation of *Azotobacter* from the garden soil

6.Isolation of *Azospirillum* from the soil/root

7.Isolation of cyanobacteria from soil/water from paddy field

8.Isolation of phosphate solubilising microorganisms from the soil

9.Isolation of phosphate solubilising bacteria from soil sample

**Suggested Readings**

1. Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India.

2. Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. India.

3. Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Primlani for Oxford and IBH Pub. Co. (P) Ltd., India.

4. Subba Rao, N.S., G.S. Venkataraman and S. Kannaiyan 1993. Biological nitrogen fixation, ICAR Pub., New Delhi.

5. Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. 1990. Biofertilizers,Scientific Publishers - Jodhpur.

**B.Sc. MICROBIOLOGY SEMESTER –IV**

**MVC-401T: FOOD, DAIRY AND BEVERAGE MANAGMENT (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Understood the various aspects of animal food such as composition and nutrition content.

**Outcome 2.** Are able to identify the role of microorganisms in the production of beverages and dairy products.

**Outcome 3.** Have developed a good knowledge of different food processing and preservation techniques.

**Outcome 4.** Developed skills of testing and maintaining aseptic conditions for management of food and beverages.

**Unit 1: Compositional, Nutritional and Technological aspects of animal foods**

**No. of hours: 14**

Flesh Foods - Meat, Fish, Poultry. Meat - Definition of carcass, concept of red meat and white meat, composition of meat, marbling, post-mortem changes in meat- rigor mortis, tenderization of meat, ageing of meat.

Fish - Classification of fish (fresh water and marine), aquaculture , composition of fish, characteristics of fresh fish, spoilage of fish- microbiological, physiological, biochemical.

Poultry - Structure of hen’s egg, composition and nutritive value, egg proteins, characteristics

of fresh egg, deterioration of egg quality, difference between broiler and layers.

II. Milk and Milk Products

Definition of milk, typical chemical composition of milk of different species i.e. buffalo, cow, goat. Composition of milk, its constituents, various steps in processing of milk. An overview of types of market milk and milk products- cheese, paneer, ice cream, ghee, butter, butter oil, flavoured milk, imitation milk.

**Unit 2: Beverages and their managment** **No. of hours: 8**

Production of wine, beer, cider, Handia, Partially fermented tea- Baimudan, Kungmei and Shoumei

**Unit 3: Food Microbiology** **No. of hours: 8**

Classification of bacteria based on temperature, pH, water activity, nutrient and oxygen requirements, Typical growth curve of micro-organisms, classification of food based on pH, definition of shelf life, perishable foods, semi perishable foods, shelf stable foods. Food infection, food intoxication

**Unit 4: Introduction to various food processing and preservation technologies No. of hours: 15**

Freezing- Introduction to refrigeration and freezing, definition, principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, introduction to thawing, changes during thawing and its effect on food.

Drying and Dehydration- Definition, drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), heat and mass transfer, factors affecting rate of drying, normal drying curve, names of types of driers used in the food industry.

Food Irradiation- Introduction, kinds of ionizing radiations used in food irradiation, uses of radiation processing in food industry, concept of cold sterilization.

Thermal Processing- Concept of pasteurization, sterilization, commercial sterilization, and blanching.

**MVC-401P: FOOD, DAIRY AND BEVERAGE MANAGMENT (PRACTICAL) SEMESTER –IV**

**TOTAL HOURS: 30** **CREDITS: 1**

1. Estimation of pH of different foods
2. Adulteration tests for different foods: i. Milk and milk products ii. Tea and coffee etc
3. To give the concept of shelf life of different foods.(processed and unprocessed)
4. To study blanching and study the concept of Asepsis.
5. To perform pasteurization and sterilization of foods.
6. Standards of identity, standards of minimum quality and standards of fill of container.
7. Identification of different types of packaging materials used in the food industry. To study methods of food processing and preservation.

**Suggested Readings**


1.Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein'sMicrobiology.9$^{th}$Edition. McGraw Hill Higher education.

2.Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

3.Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition,Elsevier Science Ltd.

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

5.Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors,Delhi, India.

6.Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-HillPublishing Company Ltd, New Delhi, India.

7.Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7$^{th}$ edition, CBSPublishers and Distributors, Delhi, India.

**B.Sc. MICROBIOLOGY SEMESTER –VI**

**MVC-601T: MICROBIAL DIAGNOSIS IN HEALTH CLINIC (THEORY)**

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good Understanding of practical aspects of collection of different clinical samples, their transport, culture and examination by staining and molecular and immunological diagnostic methods for diagnosis of microbial diseases.

**Outcome 2.** Developed skills for antibiotic sensitivity testing and different diagnostic tests using kits available in market.

**Unit 1 Importance of diagnosis of diseases** **No of Hours: 5**

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, clinical samples fordiagnosis of infectious disease.

**Unit 2 Collection of Clinical Samples** **No of Hours: 10**

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 3Microscopic examination and culture methods.** **No of Hours: 10**

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: 10**

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

**MVC-601P: MICROBIAL DIAGNOSIS IN HEALTH CLINIC (PRACTICAL) SEMESTER –VI**

**TOTAL HOURS: 30** **CREDITS: 1**

1.Identify pathogenic bacteria 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 pathogenic 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.Identification of human blood groups.

6.To perform Total Leukocyte Count of the given blood sample.

7.To perform Differential Leukocyte Count of the given blood sample.

8.To separate serum from the blood sample (demonstration).

9.To perform immunodiffusion by Ouchterlony method.

## SUGGESTED READING


1.Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, UniversitiesPress Private Ltd.

2.Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick andAdelberg's Medical Microbiology. 26th edition. McGraw Hill Publication.

3.Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2ndedition, Elsevier India Pvt Ltd.

4.Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.

5.Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical MedicalMicrobiology, 14th edition, Elsevier.

## B.Sc. MICROBIOLOGY SEMESTER –VIII

## MVC-801T: MUSHROOM CULTIVATION (THEORY)

**TOTAL HOURS: 45** **CREDITS: 3**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good Understanding of nutritional aspects and commercial use of mushrooms for human consumption.

**Outcome 2.** Developed skills for practical cultivation of mushrooms, management of diseases affecting mushrooms, mushroom harvesting and various avenues for using it into entrepreneurship.

**Unit 1: Introduction to Mushroom** **No of Hours: 5**

History and Scope of Mushroom Cultivation; Taxonomical rank of Mushroom; Vegetative characters of edible and poisonous mushrooms.

**Unit 2: Common edible Mushrooms** **No of Hours: 5**

Button Mushroom (*Agaricus bisporous*), Oyster mushroom (*Pleurotus sajorcaju*), paddy straw mushroom (*Volvariella volvacea*), Milky Mushroom (*Calocybe indica*); Other economically important and medicinal mushroom- Shiitake Mushroom (*Lentinula edodes*), Kabul Dhingri (King Oyster) Mushroom.

**Unit 3: Principle of Mushroom Cultivation** **No of Hours: 15**

Structure and construction of mushroom house. Sterilization of substrates. Spawn production culture media preparation, Preparation of mother spawn, production of planting spawn, storage/transportation of spawn, Criteria for selection of good quality spawn. Cultivation of Button mushroom and paddy straw mushroom; Introduction to microbiology laboratory- Laminar Air flow, Autoclave.

**Unit 4: Nutritional and health benefits of Mushroom No of Hours: 3**

Nutritional and health benefits of mushrooms. Therapeutic aspects- antitumour effects.

**Unit 5: Disease and Pest Management in cultivated mushrooms No of Hours: 5**

Dry Bubble and wet bubble- Major diseases of cultivated mushroom; Major insect pests- Mushroom flies / nematodes / mites.

**Unit 6: Value addition of Mushroom No of Hours: 3**

Value added products / recipes, Quality assurance, Packing and packaging, Market opportunities**.**

**Unit 7: Training / Workshop No of Hours: 9**

Sterilisation and sanitation of mushroom house, instruments and substrate; Preparation of mother culture, media preparation, inoculation, incubation and spawn production; Cultivation of *Volvariella volvacea* (paddy straw mushroom) and *Pluerotus sajorcaju* (oyster mushroom) using paddy straw/agricultural waste.

**MVC-801P: MUSHROOM CULTIVATION (PRACTICAL) SEMESTER –VIII**

**TOTAL HOURS: 30 CREDITS: 1**

1. Different parts of a typical mushroom & variations in mushroom morphology.
2. Sterilization of glassware, equipments, and culture media used in mushroom cultivation.
3. Preparation of culture media: Potato Dextrose medium, Richards medium.
4. Preparation of spawn: Grain spawn, Straw spawn, Sawdust spawn.
5. Preparation of compost and known compost formulations.
6. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves.

7. Cultivation of White button mushroom.

8. Cultivation of Paddy straw mushroom.

9. Cultivation of Oyster mushroom.

10. Cultivation of Milky mushroom.

11. Nutrient profiling and Medicinal value of mushrooms.

12. Hands on training in Mushroom cultivation farm.

13. Diseases of Mushrooms.

**SUGGESTED READING**


1. Pandey, R.K. and Ghosh, S.K. (1996). A handbook of Mushroom Cultivation. Emkey
2. Publication.
3. Pathak, V.N. and Yadav, N. (1998). Mushroom Production and Processing
4. Technology. Agrobios, Jodhpur.
5. Nita, B. (2000). Handbook of Mushrooms. Vol 1 & 2. Oxford and IBH Publishing
6. Co. Pvt. Ltd., New Delhi.
7. Tewari, P. and Kapoor S.C. (1998). Mushroom Cultivation, Mittal Publication, New
8. Delhi.
9. Kannaiyan, S. Ramasamy, K. (1980). A hand book of edible mushroom, Today & Tomorrows Printers & Publishers, New Delhi.
10. Subrata Biswas, M. Datta, S. V. Ngachan. (2012) Mushrooms: A Manual for Cultivation. PHI Learning Pvt Ltd.
11. R. Gogoi, Y. Rathaiah, T.R. Borah. (2006).Mushroom cultivation technology. Scientific Publishers, Jodhpur, India.
12. M. H. Pinkerton. (2013). Commercial Mushroom Growing. British Library Cataloguing-in- Publication data.
13. O.P. Ahlawat, R.P. Tewari (2007).Cultivation technology of Paddy straw Mushroom. National Research Centre for Mushroom (ICAR), Chambaghat, Solan, India.
14. Board NIIR. Handbook on Mushroom Cultivation and Processing. Centre for Information Technology.
15. Tripathi, D.P. (2005).Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt .Ltd,

New Delhi.

16. Pathak Yadav Gour. (2010).Mushroom Production and Processing Technology. Published by Agrobios (India).

**B.Sc. (HONOURS) MICROBIOLOGY SEMESTER –I**

**SEC -101: BIOFERTILIZERS AND BIOPESTICIDES**

**TOTAL HOURS: 30** **CREDITS: 2**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good understanding of practical aspects of production of biofertilizers.

**Outcome 2.** Understood the practical aspects of the production of biopesticides/bioinsecticides.

**Unit 1Biofertilizers** **No of Hours:10**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N2 fixers: *Rhizobium*- Isolation, characteristics, types, inoculums production and field application, legume/pulses plants

*Frankia*- Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla*-Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

**Unit 2 Non-Symbiotic Nitrogen Fixers** **No of Hours: 4**

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

**Unit 3 Phosphate Solubilizers** **No of Hours: 4**

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

**Unit 4 Mycorrhizal Biofertilizers** **No of Hours: 5**

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

**Unit 5 Bioinsecticides** **No of Hours: 7**

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

**Suggested Readings**


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

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER –II

**SEC -201: FOOD FERMENTATION TECHNIQUES**

**TOTAL HOURS: 30** **CREDITS: 2**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good understanding of different types of fermented foods and their health benefits.

**Outcome 2.** Have developed a good understanding of involvement of microorganisms in production of fermented foods and the concept of probiotic and prebiotic food.

**Unit 1Fermented foods**

Definition, types, advantages and health benefits **No of Hours: 4**

**Unit 2 Beverages** **No of Hours: 8**

Production of wine, beer, cider, Handia, Partially fermented tea- Baimudan, Kungmei and Shoumei

**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 and Prebiotic food** **No of Hours: 4**

Definition, types, microorganisms and health benefits

**Suggested Readings**


1. Hui Y H, Meunier-Goddik L, Joseph sen J, Nip W K, Stanfield P S (2004). Handbook of food and fermentation technology, CRC Press

2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Wood head Publishing.

3. Yadav J S, Grover, Sand Batish V K (1993). A comprehensive dairy microbiology, Metropolitan

4. Jay J M, Loessner M J, Golden D A (2005). Modern Food Microbiology, 7th edition. Springer

## B.Sc (HONOURS) MICROBIOLOGY SEMESTER – III

**SEC-301: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER**

**TOTAL HOURS: 30** **CREDITS: 2**

**Time: 3 Hours** **Full marks for End Semester: 60**

**Internal Assessment: 15 Marks (Mid Sem – 10 & Assignment Work – 5 Marks)**

Instructions to External Question Setter for End Semester Examination (60 Marks): There will be three section of questions. Section A will be very short answer type questions consisting of 5 compulsory questions carrying 1 mark each. Again, Section B will be short answer type questions wherein two questions are to be answered out of four questions carrying five marks each. Lastly, Section C will be long answer type questions wherein three questions are to be answered out of five questions carrying fifteen marks each.

**LEARNING OUTCOMES**

**Course learning outcomes:** At the conclusion of this course the students-

**Outcome 1.** Have developed a good understanding and skills of the analysis of air, water and soil.

**Outcome 2.** Have developed a good understanding of how the analysis of air, water and soil contribute to control of environmental pollution.

**Unit 1 Aeromicrobiology** **No of Hours: 4**

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

**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 ofwater samples: (a) standard qualitative procedure: presumptive test(MPN test), confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

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

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

**Suggested Reading**


1. Da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water-A Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press.