GOVERNMENT COLLEGE FOR WOMEN(AUTONOMOUS)
SAMBASIVAPET, GUNTUR
NAAC RE-ACCREDITED "B++" GRADE INSTITUTION
Phone: (off) 0863-222093

BSc MICROBIOLOGY (HONOURS)

FOUR-YEAR FULL-TIME PROGRAMME Choice based credit system
(Eight-Semester Course) (w.e.f 2023) I, II, III & IV Semesters

&

BSc MICROBIOLOGY

THREE-YEAR FULL-TIME PROGRAMME Choice based credit system
(Six-Semester Course) (w.e.f 2020) V & VI Semesters

COURSE BOOK 2024 TO 25

COURSE CONTENTS APPROVED IN BOARD OF STUDIES HELD ON 09-08-2024

B.Sc, MICROBIOLOGY (HONOURS) SYLLABUS (W.E.F. 2023-24)

SEMESTER- I

1LS-CM-01: INTRODUCTION TO CLASSICAL BIOLOGY

Hours/Week: 5 Credits: 4

Learning objectives:

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

Course Outcomes:

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

Unit 1: Introduction to systematics, taxonomy and ecology.

1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy. 1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature. 1.3. Ecology – Concept of ecosystem, Biodiversity and conservation. 1.4. Pollution and climate change.

Unit 2: Essentials of Botany.

2.1. The classification of plant kingdom. 2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones). 2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos. 2.4 Mushroom cultivation, floriculture and landscaping.

Unit 3: Essentials of Zoology

3.1. The classification of Kingdom Animalia and Chordata. 3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders 3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis) 3.4 Economic Zoology – Sericulture, Apiculture, Aquaculture

Unit 4: Cell biology, Genetics and Evolution

4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle. 4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene. 4.3. Central Dogma of Molecular Biology. 4.4. Origin of life

Unit 5: Essentials of chemistry

5.1. Definition and scope of chemistry, applications of chemistry in daily life. 5.2. Branches of chemistry 5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds. 5.4. Green chemistry

References:

1. Sharma O.P., 1993. Plant taxonomy. 2nd Edition. McGraw Hill publishers.
2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4th edition. S. Chand publishers, New Delhi, India.
3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.
4. Rastogi, S.C., 2019. Essentials of animal physiology. 4th Edition. New Age International Publishers.
5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology.
S. Chand publishers, New Delhi, India.
6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.
7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5th Edition. Pearson publishers.
9. Subrata Sen Gupta, 2014. Organic chemistry. 1st Edition. Oxford publishers.

ACTIVITIES:

1. Make a display chart of life cycle of nonflowering plants.
2. Make a display chart of life cycle of flowering plants.
3. Study of stomata
4. Activity to prove that chlorophyll is essential for photosynthesis
5. Study of pollen grains.
6. Observation of pollen germination.
7. Ikebana.
8. Differentiate between edible and poisonous mushrooms.
9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.
10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell
11. Visit to Zoology Lab and observe different types of preservation of specimens
12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow
13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit
14. List out different hormonal, genetic and physiological disorders from the society

B.Sc, MICROBIOLOGY (HONOURS) SYLLABUS (W.E.F. 2023-24)
SEMESTER- I

1LS-CM-02: INTRODUCTION TO APPLIED BIOLOGY

Hours/Week: 5 Credits: 4

Learning objectives: The student will be able to learn the foundations and principles of microbiology, immunology, biochemistry, biotechnology, analytical tools, quantitative methods, and bioinformatics.

Course Outcomes:

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules and gain knowledge on biotechnology principles and its applications in food and medicine.
3. Outline the techniques, tools and their uses in diagnosis and therapy.
4. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

Unit 1: Essentials of Microbiology and Immunology No. of hours: 15

1.1. History and Major Milestones of Microbiology; Contributions of Antony von Leewenhock, Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.
1.2. Groups of Microorganisms – General characteristics of prokaryotic (Bacteria & Archaea) and Eukaryotic Microorganisms (Fungi) and Viruses.
1.3. Applications of microorganisms in – Food, Agriculture, Environment, and Industry.
1.4. Immune system – Immunity, types of immunity, cells and organs of immune system.

Unit 2: Essentials of Biochemistry No. of hours: 15

2.1. Biomolecules I – Classification of Carbohydrates and biological importance of Monosaccharides and disaccharides. Classification and biological importance of Lipids.
2.2. Biomolecules II – General properties and classification of Amino acids based on polarity. Classification of proteins based on function. Biologically important peptides.
2.3. Biomolecules III – Structure and functions of Nucleic acids -DNA and RNA: t-RNA, m-RNA, r-RNA.
2.4. Basics of Metabolism – Concept on Anabolism and catabolism

Unit 3: Essentials of Biotechnology No. of hours: 15

3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.
3.2. Environmental Biotechnology – Bioremediation and Biofuels, Biofertilizers and Biopesticides.
3.3. Outlines of Genetic engineering – Gene manipulation using restriction enzymes, and cloning vectors; Physical, chemical, and biological methods of gene transfer.
3.4. Transgenic plants – Stress tolerant plants (biotic stress – BT cotton, abiotic stress – salt tolerance). Transgenic animals – Sheep and disease models.

Unit 4: Analytical Tools and techniques in biology – Applications No. of hours: 15

4.1. Applications in forensics – PCR and DNA fingerprinting
4.2. Immunological techniques – Immunoblotting and ELISA.
4.3. Monoclonal antibodies – Applications in diagnosis and therapy.
4.4. Eugenics and Gene therapy

Unit 5: Biostatistics and Bioinformatics No. of hours: 15

5.1. Introduction to biostatistics, organization of statistical investigation, types of data- primary and secondary data, methods of data collection; sampling- methods of sampling- random, nonrandom; central tendency definition with example – mean, median, mode
5.2. Measures of dispersion – introduction, range, standard deviation and variance – definition and formula; probability- introduction, definition with example;
5.3. Introduction to Bioinformatics; types of biological data; Scope and Applications of Bioinformatics in various fields of biology.
5.4. Genomics- nucleic acid data bases – NCBI, EBI; Proteomics; Protein databases – SWISS-PROT. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

Additional module (Not for examination): Tests of significance- student T test, chi square test. Protein Databases: PDB, Protein 3D structures

REFERENCES

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11th Edition. Pearson publications, London, England.
2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5 th Edition. McGraw Education, New York, USA.
3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.
4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.
6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3rd Edition. Cambridge Publishers.
7. U. Sathyanarayana, 2005. Biotechnology. 1st Edition. Books and Allied Publishers pvt. ltd., Kolkata. 8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
8. Arthur M. Lesk. Introduction to Bioinformatics. 5th Edition. Oxford publishers.
10. AP Kulkarni, 2020. Basics of Biostatistics. 2nd Edition. CBS publishers.

ACTIVITIES

1. Identification of given organism as harmful or beneficial.
2. Observation of microorganisms from house dust under microscope.
3. Finding microorganism from pond water.
4. Visit to a microbiology industry or biotech company.
5. Visit to a waste water treatment plant.
6. Retrieving a DNA or protein sequence of a gene'
7. Performing a BLAST analysis for DNA and protein.
8. Problems on biostatistics.
9. Field trip and awareness programs on environmental pollution by different types of wastes and hazardous materials.
10. Demonstration on basic biotechnology lab equipment.
11. Preparation of 3D models of genetic engineering techniques.
12. Preparation of 3D models of transgenic plants and animals.

[NOTE: In the colleges where there is availability of faculty for microbiology and biotechnology, those chapters need to be handled by microbiology and biotechnology faculty. In other colleges, the above topics shall be dealt by Botany and Zoology faculty]

II SEMESTER
2MB-03: INTRODUCTION TO MICROBIOLOGY
Credits -_3

4hours/week

Course Outcomes: On successful completion of the course, the students will be able to

1. Understand the historical significance of microbiology, the contributions of key Scientists, the classification and place of microorganisms in the living world.
2. Comprehend the scope and applications of microbiology, including the origin of microbial life and the distinction between eukaryotic and prokaryotic cells.
3. Describe the characteristics of bacteria, archaea, fungi, algae, protozoa, viruses and their diversity in structure.
4. Develop practical skills in aseptic techniques, growth media preparation, isolation methods, and the identification of bacteria and fungi.

Unit - 1: History of Microbiology No. of Hours: 12

1.1 Discovery of Microscope and microbial world by Anton von Leeuwenhoek
1.2 Golden era of Microbiology- Refutation of abiogenesis; Germ theory of Disease; Discovery of vaccination; Discovery of penicillin
1.3 Major contributions of Scientists: Edward Jenner, Louis Pasteur, Robert Koch, Joseph Lister, Ivanowsky, Martinus Beijerinck and Sergei Winogradsky, Alexander Fleming

Unit - 2: Place of Microorganisms in the living world No. of Hours: 12

2.1. Haeckel's three Kingdom concept, Whittaker's five kingdom concept, three domains concept of Carl Woese
2.2 Definition and scope of Microbiology; Applications of Microbiology; Diverse groups of Microorganisms
2.3. Origin of microbial life on earth- Timeline, Miller's Experiment, endosymbiosis (cyanobacteria), distinguishing features of eukaryotic and prokaryotic cell

Unit - 3: Prokaryotic microorganisms and Viruses No. of Hours: 12

3.1. General characteristics of Bacteria (Morphology, Nutrition- metabolic diversity and reproduction)
3.2. General characteristics of Archaea. Differentiating characters of Archaea and Bacteria.
3.3 General characteristics of virus (Nature, composition, size, host specificity, diversity in structure)

Unit - 4: Eukaryotic microorganisms No. of Hours: 12

4.1. Fungi - Habitat, nutrition, vegetative structure and modes of reproduction;
4.2. Micro Algae- Habitat, thallus organization, photosynthetic pigments, storage forms of food, reproduction.
4.3. Protozoa–Habitat, cell structure, nutrition, locomotion, excretion, reproduction, encystment.

Unit - 5: Growing Microbes in Lab No. of Hours:12

5.1. Inoculation - Composition of basic growth media, solid and liquid. Aseptic methods of introducing inoculum to growth media;
5.2. Brief outline of Pure culture, mixed culture and contaminated culture
5.3. Staining techniques of bacteria and fungi. Observation of colour, size and shape of colonies;

III. Skill Outcomes:

1. Implement safety protocols, handling hazardous materials, and practicing personal protective measures.
2. Identify microscope parts, adjusting focus and diaphragm, and accurately observing and documenting microscopic images.
3. Prepare smears, identifying different microorganisms, and interpreting microscopic characteristics.
4. Analyze electron micrographs, identifying virus types, and describing their morphology and size.
5. Operate Autoclave, Hot Air Oven, and Laminar Air Flow Chamber for sterilization and decontamination purposes.

II SEMESTER

2MB-03P: INTRODUCTION TO MICROBIOLOGY

credits -_1

1. Good Laboratory Practices and Biosafety
2. Compound Light microscope -Parts and its handling
3. Microscopic observation of Bacteria (E. coli) in water, Algae (Chlorella, Spirulina, volvox) Fungi and protozoa
4. Observation of electron micrographs of viruses (Lambda, T4, TMV, HIV, SARS CoV-2, Polio)
5. Laboratory equipment -Working principles of Autoclave, Hot air oven, Laminar airflow chamber IV.

REFERENCES:

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (1993). Microbiology. 5th Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
2. ·Dube, R.C. and Maheswari, D.K. (2000) General Microbiology. S Chand, New Delhi. Edition), Himalaya Publishing House, Mumbai.
3. Prescott, M.J., Harley, J.P. and Klein, D.A. (2012). Microbiology. 5th Edition, WCB McGraw Hill, New York.
4. Reddy, S.M. and Reddy, S.R. (1998). Microbiology Practical Manual, 3 rd Edition, Sri Padmavathi Publications, Hyderabad.
5. Singh, R.P. (2007). General Microbiology. Kalyani Publishers, New Delhi.
6. Stanier, R.Y., Adelberg, E.A. and Ingram, J.L. (1991). General Microbiology, 5th Ed.,Prentice Hall of India Pvt. Ltd., New Delhi.
7. Jaya Babu (2006). Practical Manual on Microbial Metabolisms and General Microbiology. Kalyani Publishers, New Delhi.
8. Gopal Reddy et al., Laboratory Experiments in Microbiology

V. Co-Curricular Activities:

1. Establish a Microbiology Club where students can come together to discuss and explore various topics related to microbiology.
2. Organizing microbiology-themed events like microbiology day 3 Poster presentations, oral presentations, and Q&A sessions.
3. Field Trips to Microbiology-related Sites
4. Establish a Microbiology Journal Club where students can review and discuss scientific articles related to microbiology.

II SEMESTER

2MB-04: BACTERIOLOGY AND VIROLOGY

Credits -_3

4hours/Week

I. Course Outcomes: On successful completion of the course, the students will be able to

1. Understand the concept of prokaryotic diversity and taxonomy, discovery, nature, and definition of viruses.
2. Identify and describe the salient features of various bacterial groups.
3. Describe the replication processes of specific viruses.
4. Comprehend the concept of oncogenic viruses, and role of viruses in the ecosystem.

Unit -1: Bacterial Taxonomy and Ultrastructure No. of Hours: 12

1.1. Introduction to prokaryotic diversity and taxonomy. Types of classification: Numerical and Phylogenetic classification systems.
1.2. Introduction to Bergy's manual of Systematic Bacteriology
1.3. Non-Culturable bacteria and Metagenomics
1.4. Ultrastructure of a Bacterial Cell-Invariable components -cell wall, Structure and/Functions of cell membrane, cytoplasm, nucleoid; Variable components- plasmid, inclusion bodies, flagella (structure and arrangement), pili, capsule, endospore.

Unit - 2: Type studies of Bacteria and Archae No. of Hours:12

2.1. Salient features of: a) Photosynthetic bacteria - Purple bacteria, Green bacteria and Anabaena b) Gliding bacteria - *Myxobacteria* and *Cytophaga* group c) Filamentous bacteria-Actinomycetes d) Spore forming bacteria - Bacillus and Clostridia
e) Miscellaneous –
Mycoplasma, Rickettsia, Chlamydia
2.2. Salient features of Fermentative bacteria, Nitrogen fixing bacteria
2.3. Salient features of Extremophiles- Methanogens and halobacteria.

Unit- 3: General Properties and Classification of Viruses No. of Hours:12

3.1. Discovery of viruses, Nature and definition of viruses, general properties
3.2. Hierarchy of ICTV nomenclature
3.3. Outline of Baltimore system of classification.
3.4. Cultivation of Viruses, Virus Purification and Assay.

Unit-4: Replication of Viruses No. of Hours:12

4.1. General features of Viral Replication
4.2. Replication of bacteriophages: T4, lambda; Replication of plant viruses: TMV
4.3. Replication of animal viruses: Polio, Influenza, Adeno Virus, HIV

Unit-5: Pathogenic and other Viruses No. of Hours:12

5.1. Defective Viruses- Viroids, virusoids, satellite viruses and Prions.
5.2. Emergence of Viral Pathogens, Introduction to Oncogenic viruses, Concept of Oncogenes and Protooncogenes
5.3. Role of viruses in Ecosystems; Applications in Biotechnology: Vectors, vaccines and gene therapy

III. Skill Outcomes: On successful completion of the course, the students will be able to

1. Develop practical skills in the isolation, identification, and cultivation of bacteria.
2. Acquire knowledge about the preparation of growth media and study host-pathogen interactions.
3. Gain the ability to examine the bacteria through microscopy.
4. Demonstrate proficiency in isolating bacteria from natural environment

II SEMESTER
2MB-04P: - BACTERIOLOGY AND VIROLOGY
Credits -1

1. Study of bacteria by colony observation and staining-simple, Gram Staining
2. Observation of motility and capsule in bacteria
3. Isolation of bacteria using Winogradsky column and observation
4. Study of viruses (Bacteriophage, TMV and HIV) using micrographs
5. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
6. Studying isolation and propagation of animal viruses by chick embryo technique.
7. Study of cytopathic effects of viruses using photographs.
8. Perform local lesion technique for assaying plant viruses.

References:

1. Prescott, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB Mc Graw Hill, New York, (2002).
2. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
3. Alcomo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
4. Black J.G. Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
5. Tom Besty, D.C Jim Koegh. Microbiology Demystified McGRAW-HILL.
6. Christopher Burrell Colin Howard Frederick Murphy. Fenner and White's Medical Virology 5th Edition. Academic Press

Co-Curricular Activities:

1. Invite guest speakers, to provide insights into the latest advancements and emerging trends in bacteriology and virology.
2. Conduct laboratory workshops that allow students to gain hands-on experience in bacterial culture techniques
3. Case Study Competitions: Organize case study competitions where students can work in teams to analyze and solve hypothetical cases related to bacteriology and virology
4. Arrange field trips to microbiology research facilities, such as government labs, industrial settings, or healthcare institutions

SEMESTER- III

3MB-05: **EUKARYOTIC MICROORGANISMS (COURSE 5)**

TOTAL HOURS: 60 **CREDITS: 3**

On successful completion of the course, the students will be able to

1. Understand the characteristics, classification, and reproductive mechanisms of fungi, algae, and protozoa.
2. Recognize the importance of fungi in biotechnology, including their roles in food production, medicine, and agriculture.
3. Comprehend the significance of algae in various industries, the environment, and as a source of food.
4. Identify pathogenic protozoa and understand their impact on human health and the environment.

UNIT-I: Fungi No. of hours: 9

1.1. Habitat, distribution, nutritional requirements, fungal cell ultra- structure, fungal wall, Outline classification of Fungi

1.2. Reproduction in different fungal groups- *Phycomycetes, Ascomycetes, Basidiomycetes* and *Deuteromycetes.*

1.3. Heterokaryosi s, heterothallism and parasexual mechanism.

1.4. Fungal dimorphism (*Candida albicans*)

Unit 2: Importance of Fungi No. of hours: 9

2.1. Role of fungi in biotechnology: food, medicine and pharmaceutical industry (baking, brewing, antibiotics, alcohols, enzymes, organic acids, and pharmaceuticals)

2.2. Beneficial Role of fungi in Agriculture: Biofertilizers, Myco toxins; Biological control (Myco fungicides, Myco herbicides, Myco insecticides).

2.3. Mushrooms and its cultivation. (White button, Milky and Oyster)

2.4. Fungi as plant and animal pathogens (*Cercospora, Puccinia, Candida, Aspergillus*)

Unit 3: Algae **No. of hours: 9**

3.1. Algae- occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves, outline classification

3.2. Vegetative, asexual and sexual reproduction in Algae

3.3. Photosynthetic apparatus, and outlines of Photosynthesis in Algae

Unit 4: Importance and cultivation of Algae **No. of Hours: 9**

4.1. Importance of algae in agriculture, industry, environment and food with examples.

4.2. Algal culture techniques- Indoor, Outdoor, Closed, Open, Batch, continuous, Fed batch

4.3. Culture media and growth parameters for algal cultivation (Spirulina)

Unit 5: Protozoa **No. of Hours: 9**

5.1. General characteristics with special reference to *Amoeba, Paramecium*

5.2. Pathogenic Protozoa- *Plasmodium*, *Leishmania* and *Giardia*

5.3. Importance of protozoa (in waste management, soil fertility, industry and scientific study)

5.4. Culturing protozoans from natural sources-Hay water, pond water, Chalkley's solution

5.5. Haplontic (*Chlamydomonas*), Diplontic (*Cladophora*), Diplobiontic (*Polysiphonia*) life cylcles of algae

II. Skill Outcomes:

On successful completion of the course, the students will be able to

1. Develop practical skills in the isolation, identification, and cultivation of fungi and algae.
2. Acquire knowledge about the preparation of growth media and study host-pathogen interactions.
3. Gain the ability to examine the vegetative and reproductive structures of selected genera through microscopy.
4. Demonstrate proficiency in purifying and preserving pure cultures of common algae and fungi.

III SEMESTER

3MB-05P**: - EUKARYOTIC MICROORGANISMS**

TOTAL HOURS: 30 **CREDITS: 1**

1. Preparation of Potato Dextrose Medium.
2. Isolation and identification of pathogenic and non-pathogenic fungi.
3. Study of host-pathogen interaction.
4. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus* and *Alternaria*
5. Purification and preservation of pure cultures of common algae and fungi.

REFERENCES

1. Alexopoulus, C.J., Mims,C.W. and Blackwel, M, Introductory Mycology. John Wiley,New York.
2. Mehrotra, R.S. and K.R.Aneja An Introduction to Mycology. New Age International press, New Delhi
3. Webster, J. Introduction to fungi. Cambridge University Press. Cambridge, U.K. (1985).
4. Bessey E.A. Morphology and Taxonomy of fungi. Vikas Publishing House Pvt. Ltd. New Delhi.
5. Jhon Webster and R W S Weber. Introduction to Fungi. Cambridge University Press 2007.
6. V. S. S. Sambamurty. A Textbook of Algae. I.K. International Publishing House Pvt.Limited, 2010
7. H.D. Kumar and H.N. Singh.A Textbook on Algae (Macmillan international college edition)

III. Co- Curricular Activities

1. Conduct hands-on microscopy workshops using to observe eukaryotic microorganisms
2. Organize field trips to natural habitats, such as forests, ponds, or marine environments, where eukaryotic microorganisms thrive.
3. Arrange culturing workshops where students can learn how to isolate and culture eukaryotic microorganisms in the laboratory.
4. Eukaryotic Microorganism Photography Contest

SEMESTER- III

3MB-06**: - BIOMOLECULES AND ENZYMOLOGY (COURSE 6)**

TOTAL HOURS: 45 **CREDITS: 3**

I. Course Outcomes: On successful completion of the course, the students will be able to

1. Understand the classification and properties of carbohydrates, including monosaccharides, disaccharides, polysaccharides, and sugar derivatives.
2. Gain knowledge of lipids and fatty acids, including their classification, structures, functions, and their role in cell signalling and metabolism.
3. Comprehend the structure and functions of amino acids and proteins, including their primary, secondary, tertiary, and quaternary structures.
4. Learn about the structure and functions of nucleic acids, including DNA and RNA, as well as the concept of base composition and nucleic acid- protein interactions. They will also be introduced to the role of vitamins in metabolism.
5. Understand the structure of enzymes, enzyme classification, and mechanisms of action. They will also learn about the factors influencing enzyme activity and various types of enzyme inhibition.

UNIT-I: Carbohydrates **No. of hours: 9**

1.1 General characters and outline classification of Carbohydrates.

1.2 Monosaccharides- Glucose, fructose, ribose; Stereo- isomerism of monosaccharides, epimers, mutarotation and anomers of glucose

1.3 Disaccharides- concept of reducing and non-reducing sugars; Sucrose, Lactose, Maltose

1.4 Polysaccharides- Storage-Starch, glycogen, Structural- Cellulose peptidoglycan and chitin

UNIT-II: Lipids and fatty acids **No. of hours: 9**

2.1 Definition and classification of lipids. Structure and properties of lipids. Importance of lipids in biological systems.

2.2 Introduction to fatty acids: definition, structure, and nomenclature. Saturated and unsaturated fatty acids.

2.3 Triglycerides: structure and function

2.4 Phospholipids: structure, function, and role in cell membranes. Steroids: structure and physiological roles. Waxes: structure, functions, and applications.

UNIT-III: Amino acids and Proteins. **No. of hours: 9**

3.1 Aminoacids –classification, structure and function.

3.2 General characteristics of amino acids and proteins. Denaturation of proteins.

3.3 Primary, secondary, tertiary and quaternary structures of Protein

UNIT-IV: Nucleic acids and Vitamins **No. of hours: 9**

4.1 Structure and functions of DNA and RNA. Types of DNA and RNA.

4.2 Base composition. A+T and G+C rich genomes. Basic concept of nucleic acids protein interactions. Chargaff's rule. Forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations, base stacking).

4.3 Concept and types of vitamins and their role in metabolism.

UNIT-V: Enzymes **No. of hours: 9**

5.1 Structure of enzyme, Apoenzyme and cofactors, prosthetic group- TPP, coenzyme -NAD, metal cofactors; Definitions of terms: enzyme unit, specific activity and turnover number. Properties of enzymes.

5.2 Classification and nomenclature of enzymes, Mechanism of action of enzymes: Lock and key hypothesis, and Induced Fit hypothesis.
5.3 Michaelis-Menten equation, Factors affecting enzyme activity
5.4 Inhibition of enzyme activity- competitive, noncompetitive, uncompetitive and allosteric inhibition.

III. Skill Outcomes:
On successful completion of the course, the students will be able to

1. Qualitatively identify mono and disaccharides
2. Qualitatively identify specific amino acids
3. Quantitatively estimate DNA
4. Quantitatively estimate protein

III SEMESTER
3MB-06P: - BIOMOLECULES AND ENZYMOLOGY
TOTAL HOURS: 30 **CREDITS: 2**

1. Qualitative tests for sugars
2. Qualitative Analysis of Aminoacids.
3. Colorimetric estimation DNA by diphenylamine method.
4. Colorimetric estimation of proteins by Biuret/Lowry method

IV. REFERENCES:
1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications,Iowa, USA.
2. Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.
3. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
5. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
6. White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.

V. Co-Curricular Activities:

1. Organize Biomolecule Modeling Workshops where students can learn to build physical models or use computer simulations to visualize biomolecules such as proteins, nucleic acids, carbohydrates, and lipids. These workshops can help students understand the three-dimensional structures and interactions of biomolecules, enhancing their comprehension of molecular biology concepts.
2. Assign Biomolecule and Enzyme Case Studies case studies that require students to analyze real-world scenarios related to biomolecules and enzymes in medicine, biotechnology, or environmental science.

SEMESTER- III

3MB-07: MICROBIAL AND ANALYTICAL TECHNIQUES (COURSE 7)

TOTAL HOURS: 45 **Credits- 3**

I. Course Outcomes:

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

1. Understand the principles and applications of microscopy techniques, including bright field microscopy and electron microscopy (SEM and TEM), as well as staining techniques.
2. Know various sterilization and disinfection techniques, including physical methods (dry heat, moist heat, filtration, radiation) and chemical methods (disinfectants, alcohols, aldehydes, fumigants, phenols, halogens, heavy metals).
3. Perform pure culture isolation, maintenance and preservation of cultures, cultivation of anaerobic bacteria, and accessing viable non- culturable bacteria (VNBC).
4. Understand the principles and applications of spectrophotometry and chromatography techniques, including UV-visible spectrophotometry, colorimetry, turbidometry, paper chromatography, and column chromatography.
5. Gain knowledge of centrifugation principles and applications, electrophoretic techniques (agarose and SDS polyacrylamide gel), and the principles and applications of radioisotopes.

Unit -1: Microscopy **No. of Hours: 9hrs**

1.1 Microscopy: Principle, mechanism and applications of Bright field microscope.

1.2 Principle, mechanism and applications of electron microscope (SEM and TEM). Micrometry.

1.3 Staining Techniques – Simple, negative and Differential staining techniques (Gram staining, spore staining, Acid fast staining).

Unit-2: Sterilization and disinfection techniques No. of Hours: 9hrs

2.1 Sterilization, Disinfection, Antiseptic, Germicide, Sanitizer, Fungicide, Virucide, Bacteriostatic and Bactericidal agent.

2.2 Physical methods of microbial control: Dry heat-Incineration, Hot air oven; Moist heat- Pressure cooker, autoclave; Filter sterilization- laminar air flow, Membrane filter; Radiation methods – UV rays, Gamma rays.

2.3 Chemical methods of microbial control: disinfectants, types and mode of action- alcohols, aldehydes, fumigants, phenols, halogens and heavy metals.

Unit -3: Microbiological techniques **No. of Hours: 9hrs**

3.1 Pure culture isolation: Streaking, serial dilution and plating methods, micromanipulator; cultivation.

3.2 Maintenance and preservation/stocking of pure cultures: sub culturing, overlaying cultures with mineral oils, lyophilization, sand cultures, storage at low temperature, Culture collection centers(MTCC, ATCC, DSMZ);

3.3. Cultivation of anaerobic bacteria; Accessing Viable non-culturable bacteria (VNBC). Buffers in culture medium. Cultivation of fungi, Actinomycetes.

Unit-4: Spectrophotometry & Chromatography **No. of Hours: 9**

4.1 Spectroscopy – Principle, laws of light absorption, Instrumentation and applications of UV- visible spectrophotometer. Colorimetry and turbidometry.

4.2 Chromatography: Principles and applications of paper chromatography (Ascending, Descending and 2-D), thin layer chromatography.

4.3 Principle and applications of column chromatography (Partition, adsorption, ion exchange, exclusion and affinity chromatography). Column packing and fraction collection.

Unit - 5: Centrifugation, Electrophoresis & Radio isotopes No. of Hours: 9

5.1. Centrifugation-Principles, types and applications.

5.2 Electrophoretic technique (agarose and SDS polyacrylamide gel) its Components, working principle and applications

5.3 Radioisotopes– Radio isotopes used in biology (C^{14}, P^{32} & S^{35}) and their applications. Principle of autoradiography.

II. Skill Outcomes:

On successful completion of the course, the students will be able to

1. Recognize different microscopy techniques, identify microbial cell structures, interpret micrograph images, and understanding the principles of image contrast.
2. Prepare stained slides, differentiate stained and unstained structures, recognizing staining techniques, and describing the staining characteristics of microbial cells.
3. Perform the staining procedure, distinguishing between Gram-positive and Gram-negative bacteria, recognizing the importance of Gram's staining in bacterial classification, and interpreting Gram-stained slides.
4. Understand sterilization principles, operate autoclave and hot air oven, implement proper sterilization protocols, ensure sterility of media and glassware, and recognize the importance of sterile techniques in microbiology.
5. Understand streaking techniques, perform streak plate method, obtain isolated colonies, recognize contamination, and demonstrate proficiency in maintaining pure cultures for further study.

3MB-07P: MICROBIAL AND ANALYTICAL TECHNIQUES (PRACTICAL)

Total hours: 30 Credits:2

1. Study of bright field, dark field and phase contrast, Electron microscope micrographs to visualize microbial cells.
2. Simple staining & Negative staining.
3. Gram’s staining.
4. Sterilization of medium using Autoclave, Sterilization of glassware using Hot Air Oven.
5. Isolation of pure cultures of bacteria by streaking method.
6. Isolation of bacteria from natural habitat by spread and pour plate method (using serial dilution method)
7. Separation of monosaccharides/amino acids by paper/thin layer chromatography.
8. Demonstration of column packing in gel filtration chromatography.
9. Determination of absorption max for an aromatic amino acid.
10. Separation of bacterial cells (cell pellet) from broth culture by using a laboratory scale centrifuge.
11. Separation of DNA fragments by Agarose gel electrophoresis.

V REFERENCES:

1. Pelczar M., Chan E.C.S. and Krieg, N.R. Microbiology. Tata Mc Grew Hill Publishing Co. Ltd., New Delhi.
2. Stainier R.V., Ingraham, J.L., Wheelis, M.L. and Painter P.R. The Microbial World. Printice-Hall of India (Pvt.) Ltd., New Delhi
3. Wilson& Walker. Principles and Techniques in Practical B i o c h e m i s t r y . 5th EditionCambridge University Press (2000).
4. Murphy D.B. Fundamental of Light Microscopy & Electron Imaging.1st Edition. Wiley Liss. (2001).
5. K L Ghatak. Techniques and Methods In Biology PHI Publication (2011)
6. Pranav Kumar. Fundamentals and Techniques of Biophysics and Molecular Biology (2016)
7. Aurora Blair. Laboratory Techniques & Experiments in Biology.Intelliz Press
8. D.T Plummer. An Introduction to Practical Biochemistry. McGraw Hill Publication 1987
9. Beckner, W.M., Kleinsmith L.J and Hardin J. The world of cell. IV edition Benjamin /Cummings (2000)

VI. Co-Curricular Activities:

1. Competition in performing laboratory techniques like staining
2. Artwork with bacteria or fungi in petridish
3. Quiz in identifying microscopic technique in various micrographs

III SEMESTER

3MB-08: **CELL BIOLOGY AND GENETICS (COURSE 8)**

TOTAL HOURS: 45 **Credits- 3**

I. Course Outcomes: By the Completion of the course the learner should able to–

1. Understand cell theory, cell organelles, the cell cycle, and the role of the cytoskeleton.
2. Students will comprehend the structure and functions of the cell membrane, nuclear envelope, and nucleolus, as well as gain basic knowledge of cancer development.
3. Learn about protein sorting, intracellular signal transduction pathways, programmed cell death, stem cells, and specialized chromosomes.
4. Gain knowledge of Mendelian genetics, including mono-hybrid and dihybrid crosses, inheritance patterns, and allele frequencies.
5. Understand the concepts of linkage, crossing over, the Hardy-Weinberg Law, natural selection, genetic drift, and the mechanisms of sex determination and inheritance.

Unit 1 **Hours: 09**

1.1 Cell theory and cell organelles (Mitochondria, Chloroplasts, Lysosomes, Glyoxysomes and Peroxisomes, Golgi apparatus and ER).
1.2 Prokaryotic cell, eukaryotic cell(plant cell and Animal cell)
1.3 Cell cycle and its regulation. Mitosis.
1.4 Cytoskeleton: Structure and organization of actin, myosin and intermediate filaments, microtubules, and their role.

Unit 2 **Hours: 09**

2.1 Structure and functions Cell membrane, proton pumps associated (Na-K, Cacalmodulin etc. and their distribution),
2.2 Endocytosis phagocytosis, pinocytosis, exocytosis.
2.3 Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane, Nucleolus.
2.4 Elementary knowledge of development and causes of cancer; Oncogenes and suppressor genes, types of cancer, benign and malignant cells. Characteristics of cancer cells.

Unit 3 **Hours: 09**

3.1 Basic structure of cell signaling system, extracellular first messengers, intracellular secondary messengers.
3.2 eukaryotic cell to cell signaling (endocrine hormone signaling, cytokine signaling), prokaryotic cell to cell signaling (quorum sensing, bacterial pheromones)
3.3 Protein sorting and Transport Intracellular signal transduction pathways (GPCR , ERK Pathway, mTOR Signaling)
3.4 Apoptosis: Programmed Cell Death, triggering of apoptosis, effector molecules of apoptosis, induction of apoptosis by microbes, activation of host cell receptors that signals apoptosis

UNIT 4 **Hours: 09**

4.1 Mundelein Genetics, Mono hybrid and Dihybrid cross, Law of dominance segregation and Independent assortment.
4.2 Chromosome theory of inheritance, specalised chromosomes – polytene, lam Specialized chromosomes (polytene, lampbrush),Pedigree analysis, Incomplete dominance and co-dominance.
4.3 Multiple alleles, lethal alleles, Epistasis.

Unit – 5 **Hours: 09**

5.1 Linkage and Crossing over, measure of linkage intensity. Molecular mechanism of crossing over. factor affecting crossing over, types of crossing over. Difference between linkage and crossing over.
5.2 Hardy-Weinberg Law, natural selection, Genetic drift.
5.3 Sex determination – Sex linked inheritance, extra chromosomal Inheritance

Skill Outcomes: On successful completion of the course, the students will be able to

1. Develop proficiency in cell counting and viability assessment techniques.
2. Observe and analyze mitosis and meiosis in onion root tips, understanding their stages and significance.
3. Identify and analyze the ultrastructure of cells through electron micrographs.
4. Recognize and interpret cancer cells through permanent slides or photographs.
5. Understand genetic concepts like linkage, recombination, gene mapping, DNA fingerprinting, and pedigree chart analysis

III SEMESTER

3MB-08P: - CELL BIOLOGY AND GENETICS

Hours: 30 **Credits -1**

1. Cell counting and Viability
2. Mitosis from onion root tips
3. Meiosis of onion root tips
4. Study of ultrastructure of cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes, SER and RER)
5. Identification and study of types of cancer, cancer cells by permanent slides/ photographs.
6. Study of Linkage, recombination, gene mapping using marker-based data from Drosophila.
7. Demonstration of DNA fingerprinting.
8. Pedigree chart analysis.

III. REFERENCES:

1. A.J.F Griffiths, S. R Wessler, S. B Carroll & J. Doebley, An Introduction to Genetic Analysis,. 10th Ed., W.H. Freeman & Company (New York) 2010
2. Geoffrey M. Cooper and Robert E. Hausman - The cell a molecular approach.
3. Bruce Alberts , Rebecca Heald, et al. Molecular Biology Of The Cell
4. Arnold Berk (Author), Chris A. Kaiser (Author), Harvey Lodish (Author), Angelika Amon (Author), Molecular Cell Biology.
5. Benjamin Lewin Genes
6. Eldon John Gardner, Michael J. Simmons, D. Peter Snustad Principles of Genetics
7. Karp G, John Wiley Cell Biology
8. Jane B. Reece (Author), Martha R. Taylor (Author), Eric J. Simon (Author), Jean L. Dickey , Campbell Biology: Concepts and Connections
9. Veer Bala Rastogi, Genetics B D Singh, Genetics

IV. Co-Curricular Activities:

1. Laboratory demonstrations where students can observe and participate in various experiments related to cell biology and genetics.
2. Guest Lectures: Invite experts and professionals from the field of cell biology and genetics to deliver guest lectures. They can share their research, industry experiences, and advancements in the field, providing students with valuable insights and exposure to real-world applications.
3. Seminars and Workshops on emerging areas, such as gene editing technologies, stem cell research, or personalized medicine
4. Research Project on literature reviews, designing experiments, and analyzing data.
5. Science Outreach Programs: Giving presentations at local schools, or creating educational materials

4MB-09: **MOLECULAR BIOLOGY AND MICROBIAL GENETICS (COURSE 9)**
IV SEMESTER

TOTAL HOURS: 45 **Credits- 3**

I. Course Outcomes: By the Completion of the course the learner should able to–

1. Understand the nature of genetic material, its organization in prokaryotes and eukaryotes, and the role of DNA and RNA.
2. Explain the process of DNA replication in prokaryotes and the involvement of enzymes and factors. Recognize the characteristics, types, and applications of extra chromosomal genetic elements such as plasmids and transposons.
3. Differentiate between classical and modern concepts of genes, understand gene structure, and the process of transcription.
4. Comprehend the genetic code, translation process, and regulation of gene expression in bacteria.
5. Define and classify mutations, understand their molecular basis, and gain knowledge of DNA repair mechanisms.Familiarize with genetic recombination in bacteria, including conjugation, transformation, and transduction processes

Unit - 1: DNA/RNA as genetic material, Replication of DNA No. of Hours:9

1.1 Experimental evidences that established DNA and RNA as genetic material. (Griffith, Avery-MacLeod-McCarty Experiment, Hershey & Chase) Genome organization in prokaryotes.

1.2 Replication of DNA in prokaryotes. Bidirectional and unidirectional replication, Semiconservative replication, Proof of Semiconservative replication (Messelson – Stahl Experiment). Mechanism of DNA Replication in Prokaryotes: step by step process, Enzymes and factors involved in replication- (Primase, Helicase, Gyrase, DNA polymerases, DNA ligase, SSB proteins).

1.3 Extra chromosomal genetic elements: General characters, types and applicationsof Plasmids and transposons.

Unit - 2: Concept of gene, Transcription No. of Hours:9

2.1 Classical Concept of gene: Muton, Recon and Cistron; One gene-one enzyme andone gene – one polypeptide and One gene – One Product hypotheses.

2.2 Modern concept of gene: Definition of gene; Open reading frame; structural, constitutive and regulatory genes; uninterrupted genes, Split genes- concept of introns and exons.

2.3 Protein synthesis in Prokaryotes: Transcription- Definition, difference from replication, promoter, RNA Polymerase, mechanism of transcription. RNA splicing in eukaryotes;

Unit - 3: Translation and regulation of gene expression No. of Hours:9
Protein synthesis in Prokaryotes

3.1 Genetic code: Salient features, Wobble hypothesis.

3.2 Translation- Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides. Inhibitors of protein synthesis.

3.3 Regulation of gene expression in bacteria – lac operon.

Unit - 4: Mutations and DNA repair No. of Hours: 9

4.1 Mutations: Definition and types of Mutations (Spontaneous and induced, Somatic and germline); Physical and chemical mutagens;

4.2 Molecular basis of mutations (base pair changes, frame shifts, deletions, inversions, tandem duplications, insertions); Functional mutants (loss and gain of function mutants); Uses of mutations.

4.3 Outlines of DNA repair mechanisms: Direct repair, Excision repair, Mismatch Repair,

Recombination Repair, SOS Repair.

Unit - 5: Genetic recombination in bacteria **No. of Hours: 9**

5.1 Conjugation - Definition, F-factor, F+ & Hfr, mechanism of conjugation,applications of conjugation;
5.2 Transformation- Discovery, mechanism of transformation, Competence Factors affecting transformation and application of transformation.
5.3 Transduction- discovery, mechanism and types of transduction.

Skill Outcomes:

On successful completion of the course, the students will be able to

1. Performing cell lysis and purification, quantifying DNA, and recognizing the importance of genomic DNA isolation.
2. Estimate DNA using UV Spectrophotometer include preparing DNA samples, measuring absorbance at 260 nm, calculating DNA concentration, and assessing DNA purity.
3. Solve Problems related to DNA and RNA characteristics, Transcription and Translation. 4. Analyze and solve problems related to DNA and RNA structure, understanding transcription and translation processes, and interpreting the impact of mutations on protein synthesis.
4. Prepare gels, loading DNA samples, visualizing DNA bands, analyzing fragment size, and understanding the principles of electrophoresis.
5. Understand Mutagenesis principles, perform UV exposure, assessing mutation frequency, and comprehend the effects of mutations on bacterial phenotypes.

IV SEMESTER
4MB-09P - MOLECULAR BIOLOGY AND MICROBIAL GENETICS

Hours: 30 **Credits -1**

1. Isolation of genomic DNA from E. coli
2. Estimation of DNA using UV spectrophotometer (A260measurement).
3. Problems related to DNA and RNA characteristics, Transcription and Translation.
4. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
5. Problems related to DNA and RNA characteristics, Transcription and Translation.
6. Induction of mutations in bacteria by UV light.
7. Study of different conformations of plasmid DNA through agarose gel electrophoresis.
8. Demonstration of bacterial transformation
9. Instrumentation in molecular biology – Ultra centrifuge, Transilluminator, PCR
10. Study of different types of DNA and RNA using micrographs and model / schematic representations
11. Study of semi-conservative replication of DNA through micrographs / schematic Representations

IV. REFERENCES

1. James D. Watson Tania A. Baker, Stephen P. Bell Alexander Gann, Michael Levine, Richard Losick, 2013, Molecular Biology of the Gene, 5th Edition, Pearson Edu Publishers.
2. Roger Y. Stanier, Edward A. Adelberg, John L. Ingraham, 1977, General Microbiology 5th edition, London Macmillan.
3. David Freifelder1986 Molecular Biology 3rd edition, Jones & Bartlett Publishers
4. T.A. Brown, Gene cloning and DNA analysis- An Introduction, 4thedition
5. Bernard R. Glick and Jack. J. Pasternak, Molecular Biotechnology. 3rdedition
6. David Freifelder.Essentials of molecular biology.Jones and Bartlett Publishers, 1998

V. Co-Curricular Activities:

1. Conduct poster presentations, oral presentations, and interactive sessions.
2. Visit laboratories employing molecular biology techniques

IV SEMESTER
4MB-10: MICROBIAL PHYSIOLOGY AND METABOLISM

TOTAL HOURS: 45 **Credits- 3**

I. Course Outcomes: By the Completion of the course the learner should able to–

1. Understand the nutritional requirements of microorganisms and the different methods of nutrient uptake. They will also gain knowledge of different nutritional groups and types of growth media used for microbial cultivation.
2. Comprehend microbial growth, including the definition of growth, generation time, and the different phases of growth. They will also learn about factors influencing microbial growth and methods for measuring it.
3. Gain knowledge of thermodynamics in biological systems, including concepts of free energy, enthalpy, and entropy. They will also learn about ATP structure and properties, oxidation-reduction reactions, and carbohydrate breakdown pathways.
4. Understand microbial respiration, including aerobic and anaerobic respiration, chemoautotrophy, and fermentative modes.
5. Differentiate the processes of oxygenic and anoxygenic photosynthesis.

UNIT I: Microbial Nutrition **No. of hours: 9**

1.1. Nutritional requirements of Microorganisms
1.2. Methods of uptake of nutrients by microbial cells- Primary and secondary active transport, concept of uniport, symport and antiport Group translocation; Iron uptake
1.3. Nutritional groups of microorganisms-based on C, energy and electron sources: autotrophs, heterotrophs, lithotrophs, organotrophs, Phototrophs, Chemotrophs;
1.4. Growth media - synthetic, nonsynthetic, selective, enrichment and differential media.

UNIT II: Microbial Growth **No. of hours: 9**

2.1. Microbial Growth- Definitions of growth, generation time and specific growth rate; different phases of growth in batch cultures;
2.2. Synchronous, continuous, biphasic growth.
2.3. Factors influencing microbial growth: Temperature, oxygen concentration, pH, Salt
2.4. Methods for measuring microbial growth - Direct microscopy, viable count estimates, turbidometry and biomass.

UNIT III: Thermodynamics; Breakdown of Carbohydrates **No. of hours: 9**

3.1. Concept of free energy, Enthalpy, Standard Free Energy change of reaction, Entropy. Principle of First and Second law of Thermodynamics.
3.2. Structure and properties of ATP, Standard Free energy change of hydrolysis of ATP. Biological oxidation-reduction reactions. Structure and Function of NAD and FAD.
3.3. Breakdown of carbohydrates· Glycolytic pathways- EMP pathway and ED; TCA cycle.

UNIT IV: Microbial Respiration and Fermentation **No. of hours: 9**

4.1. Aerobic respiration - ETS and oxidative phosphorylation
4.2. Anaerobic respiration, chemoautotrophy - oxidation of inorganic compounds - N and S.
4.3. Fermentative modes in microorganisms with special reference to alcoholic, Lactic acid fermentations

UNIT V: Bacterial Photosynthesis **No. of hours: 9**

5.1. Photosynthetic pigments, Photosynthetic apparatus in prokaryotes
5.2. Outlines of oxygenic photosynthesis in bacteria
5.3. Outlines of anoxygenic photosynthesis in bacteria

II. Skill Outcomes:

On successful completion of the course, the students will be able to

1. Understand the impact of temperature and pH on bacterial growth and metabolism.
2. Gain proficiency in colony counting techniques for microbial enumeration.
3. Analyze and interpret growth curve data to understand bacterial growth dynamics.
4. Develop skills in observing and identifying cyanobacteria under the microscope.
5. Apply knowledge of microbial growth factors and techniques to interpret and analyze experimental results.

IV SEMESTER

4MB-10P - MICROBIAL PHYSIOLOGY AND METABOLISM

Hours: 30 **Credits -1**

1. Effect of Temperature on bacterial growth
2. Effect of pH on bacterial growth
3. Colony count in Plates
4. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods
5. Observation and identification of permanent slides of cyanobacteria

IV. REFERENCES

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company Caldwell, D.R. (1995). Microbial Physiology and Metabolism, W.C. Brown Publications,Iowa, USA.
2. Lehninger, A.L., Nelson, D.L. and Cox, M.M. (1993). Principles of Biochemistry, 2 nd Edition, CBS Publishers and Distributors, New Delhi.
3. Sashidhara Rao, B. and Deshpande, V. (2007). Experimental Biochemistry: A student Companion. I.K. International Pvt. Ltd.
4. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
5. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons
6. White, D. (1995). The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York.

V. Co-Curricular Activities:

1. Assignments in nutrient utilization, energy production, metabolic pathways,
2. Students can study microbial growth curves, metabolic pathways, or physiological responses to environmental factors.
3. Organize seminars where students can deliver presentations on specific topics in microbial physiology and metabolism.
4. Create visual representations of microbial metabolic pathways.

IV SEMESTER

4MB-11: r DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

TOTAL HOURS: 45 **Credits- 3**

I. Course Outcomes:

By the Completion of the course the learner should able to–

1. Learn the principles and techniques of genetic engineering, including g restriction endonucleases, and DNA transformation.
2. Understand the use of vectors and the basics of polymerase chain reaction also explore the applications of genetic engineering in industry, agriculture and medicine.
3. Gain knowledge of blotting techniques, DNA labelling, DNA sequence basics of intellectual property rights.
4. Learn about bioinformatic resources, sequence databases, sequence align use of biostatistics in data analysis.
5. Develop skills in measuring central tendency and dispersion, understand types of data, and utilizing biostatistical software for analysis and data pr

UNIT- I: Recombinant DNA Technology **No. of Hours: 9**

1.1 Basic principles of genetic engineering. Steps in gene cloning.
1.2 Restriction endonucleases- applications of Type II restriction enzymes in genetic engineering; DNA polymerases and ligases; Use of linkers and adaptors
1.3 Vectors – Cosmid, Bacteriophages, BAC, YAC
1.4 Transformation of DNA by Chemical method, Electroporation.

UNIT- II: Applications of r-DNA technology **No. of Hours: 9**

2.1 Genomic and C-DNA Libraries, RFLP, RAPD,
2.2 Basics of Polymerase chain Reaction
2.3 Application of genetic engineering in industry, agriculture and medicine, Hybirdoma Technology.

UNIT- III: Techniques in genetic engineering and IPR **No. of Hours: 9**

3.1 Blotting Techniques.
3.2 Labeling of DNA, DNA foot printing.
3.3 DNA Sequencing-Sanger's method
3.4 Outlines of Intellectual property Rights (Patents, Trademark, Copyright)

UNIT- IV: Bioinformatics **No. of Hours: 9**

4.1. Bioinformatic resources: NCBI, EBI, DDBJ, PUBMED, BIOMED. 4.2 Sequence Databases – GENBANK, BLAST, FASTA, ExPasy, PDB, NDB, UNIPROT – SWISS PROT.
4.3 Sequence alignment – Sequence homology, pairwise sequence alignment, automated DNA sequencing, ChIP.

UNIT- V: Biostatistics **No. of Hours: 9**

5.1 Measurement of central tendency : MEAN , MEDIAN, MODE.
5.2 Measurement of dispersion : RANGE, MEAN DEVIATION , STANDARD DEVIATION.
5.3 Use of Biostatistic softwares.
5.4 Sample and population ; Types of Data , methods of Data presentation.

II. Skill Outcomes:

On successful completion of the course, the students will be able to

1. Perform plasmid DNA isolation, agarose gel electrophoresis
2. Understand the principles and applications of DNA fingerprinting for genetic profiling and identification.
3. Utilize nucleic acid and protein databases to access, retrieve, and analyze genetic and protein Sequence information
4. Apply sequence alignment algorithms and tools
5. Develop skills using bioinformatics tools and databases

IV SEMESTER

4MB-11P - DNA TECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

Hours: 30 **Credits -1**

1. Isolation of plasmid DNA by Agarose gel Electrophoresis.
2. Preparation of Recombinant vector by using T4 DNA Ligase.
3. To Understand the concept of DNA fingerprinting by Random Ampilification of Polymorphic DNA.
4. Nucleic acid and protein databases.
5. Sequence alignment
6. Sequence homology and Gene annotation.

IV. References

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings. Crueger W, Crueger A (1990)
4. Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates,Inc.
5. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications
7. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
8. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
9. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
10. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

V. Co-Curricular Activities:

1. Training of students and basic gene cloning methods.
2. Industrial visit on Recombinant products.
3. Prepearation of videos on labeling of DNA and DNA sequencing.
4. Students participation in seminars of the copyright, Patent, Trademark and IPR.
5. Assignments on PCR, Restriction enzymes , vectors , RFLP, RAPD, Hybridoma Technology, Sequence alignment tools of DNA , central tendancy , Data collection and presentation.
6. Conducting group discussion , Quiz, debate in related topics.

B.Sc, MICROBIOLOGY (CBCS) REVISED SYLLABUS (W.E.F. 2020-21)
MB404-6A INDUSTRIAL MICROBIOLOGY
SEMESTER- V

TOTAL HOURS: 60 **CREDITS: 4**

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

- Describe the industrially important microorganisms.
- Differentiate primary and secondary microbial products.
- Explain the techniques of screening industrially important metabolites from microbes
- They can discuss about different types of fermentations.
- Demonstrate the knowledge and understanding of Microbial production of industrial products.

UNIT I **No. of hours 12**

Microorganisms of industrial importance - yeasts (*Saccharomyces cerevisiae*), moulds (*Aspergillus niger*) bacteria (E.coli), Actinomycetes (*Streptomyces griseus*). Industrially important Primary and secondary microbial metabolites. Screening techniques. Techniques involved in selection of industrially important metabolites from microbes. Strain improvement Techniques. Concept on Intellectual property rights.

UNIT II **No. of hours 12**

Concept and history of fermentation; Basic concepts of Design of fermenter– Fermenter and its parts; Types of fermenters- batch, continuous and fed batch. Types of fermentation processes: solid state, liquid state, batch, fed-batch, continuous. Ingredients of Fermentation media. Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.

UNIT III **No. of hours 12**

Microorganisms involved in Pharma and therapeutic enzymes. Enzymes used in detergents, textiles and leather industries. Production of amylases and Proteases. Production of therapeutic enzymes-Streptokinase. Role of microorganisms in bioleaching, and textile industry. Biodeterioration of Paper, Paint, Textiles.

UNIT IV **No. of hours 12**

Industrial microorganisms: cell growth, microbial growth kinetics, factors affecting growth, Principles of production media, components of media, chemical composition of media. Microbial production of Industrial products: Citric acid Ethanol, Penicillin and vitamin B12

UNIT V **No. of hours 12**

Bioreactors: basic structure of bioreactor, types of bioreactors. Kinetics and methodology of batch and continuous bioreactors. Sterilization of bioreactors: fibrous filter sterilization; Aeration and agitation: agitation in shake flask and tube rollers.

MB404-6A: INDUSTRIAL MICROBIOLOGY (PRACTICAL)

SEMESTER-V

Total hours: 30 Hrs **Credits: 2**

1. Microbial Production of ethanol
2. Estimation of ethanol
3. Isolation of amylase producing microorganisms from soil
4. Production of amylase from bacteria and fungi
5. Assay of amylase
6. Demonstration of fermenter
7. Production of wine from grapes
8. Growth curve and kinetics of any two industrially important microorganisms.
9. Microbial fermentation for the production and estimation of citric acid

Suggested readings

1. Casida LE. (1991). **Industrial Microbiology**. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). **Biotechnology: A textbook of Industrial Microbiology**. 2nd Edition. Panima Publishing Company, New Delhi
3. Patel AH. (1996). **Industrial Microbiology** .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
4. Stanbury PF, Whitaker A and Hall SJ. (2006). **Principles of Fermentation Technology.** 2nd edition, Elsevier Science Ltd.
5. Tortora GJ, Funke BR, and Case CL. (2008). **Microbiology: An introduction**. 9th Edition. Pearson Education

B.Sc, MICROBIOLOGY (CBCS) REVISED SYLLABUS (W.E.F. 2020-21)
MB 404-7A: MANAGEMENT OF HUMAN MICROBIAL DISEASES AND DIAGNOSIS
SEMESTER- V

TOTAL HOURS: 60 **CREDITS: 4**

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

- List and discuss about pathogenic organisms affecting human body systems, differentiate between different types of pathogenic organisms.
- Explain types of modes of disease transmission, distinguish between methods of disease prevention and control.
- Distinguish different pathogens based on their morphological and biochemical characteristics
- Identify pathogenic organisms by serological methods
- Determine sensitivity of pathogenic organisms to various antimicrobials

UNIT I **No. of Hours: 12**
Definition and concept of health, disease, infection, and pathogen. Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems- Bacterial diseases: *Staphylococcus aureus*, *Haemophilus influenzae*, *Neisseria gonorrhoeae*; Viral diseases: SARS CoV-2, Polio Virus; Fungal disease: *Candida albicans*; Protozoan disease: *Entamoeba histolytica.*

UNIT- II **No. of hours: 12**
General account of epidemiology: principles of epidemiology, current epidemics (AIDS, nosocomial, acute respiratory syndromes). Collection of 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- III **No. of hours: 12**
Mechanism of bacterial pathogenicity, colonization and growth, virulence, virulence factors, exotoxins, enterotoxins, endotoxins and neurotoxins. 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 pathogen

UNIT- IV **No. of hours:12**
Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Diagnosis of Typhoid, Dengue and HIV, Swine flu. Role of vectors-biology of vectors. (1) House fly (2) Mosquitoes (3) sand fly.

UNIT- V **No. of hours: 12**
Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method. Epidemiological investigations to identify a disease, Problems of drug resistance and drug sensitivity. Drug resistance in bacteria

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1. Demonstration of permanent slides of the following parasites:
    a) *Entamoeba histolytica*
    b) *Ascaris spps.*
    c) *Plasmodium spps.*
    d) Mycobacterium tuberculosis & Mycobacterium leprae
2. Estimation of hemoglobin (Acid hematin and cyan methanoglobin method).
3. ESR and PCV determination.
4. Immuno hematology: Blood group typing by slide test & tube for ABO & Rh systems.
5. Isolation of bacteria in pure culture and Antibiotic sensitivity.

SUGGESTED READINGS

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelbergís Medical Microbiology. 26th edition. McGraw Hill Publication.
3. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.
4. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2ndedition, Elsevier India Pvt Ltd.
5. Tille P (2013) Baileyís and Scottís Diagnostic Microbiology, 13th edition, Mosby.

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SEMESTER- VI

INTERNSHIP