NATIONAL CURRICULUM AND CREDIT FRAMEWORK (NCCF)

Syllabus
for

MICROBIOLOGY

(w.e.f. Academic Session 2023-24)

Kazi Nazrul University
Asansol, Paschim Bardhaman
West Bengal 713340

Detailed Syllabus

Semester - 1

Course Name: Bacteriology Course Code: BSCMCBMJ101					
Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-1**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

and

Course Name: Bacteriology Course Code: BSCMCBMN101					
Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-1**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

Course Learning Outcomes:

After the completion of the course, the students will:

- Describe characteristics of bacterial cells, cell organelles, cell wall composition, and various appendages like capsules, flagella, or pili.
- Differentiate many common bacteria by their salient characteristics; classify bacteria.
- Describe the nutritional requirements of bacteria for growth; develop knowledge and understanding that several other microbes grow under extreme environments besides common bacteria.
- Perform basic laboratory experiments to study microorganisms; methods to preserve bacteria in the laboratory; calculate generation time of growing bacteria.

Course Content:

Theory

Unit – 1: History of microbiology and introduction to the microbial world. Theory of spontaneous generation, Germ theory of disease, golden era of microbiology. Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit – 2: Cell size, shape and arrangement, capsule, flagella, fimbriae, and pili. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, archaebacterial cell wall, lipopolysaccharide (LPS), spheroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell membrane: Structure, function, and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid. Endospore: Structure, formation, stages of sporulation.

Unit – 3: Nutritional requirements in bacteria and nutritional categories. Culture media: components

of media, natural and synthetic media, chemically defined media, complex media, selective, differential, enriched, and enrichment media. Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, and radiation. Chemical methods of microbial control: disinfectants, types, and mode of action. in vitro cultivation of microorganisms; Sterilization techniques (physical & chemical sterilization). Conditions for microbial growth. Pure culture isolation: Streaking, serial dilution, and plating methods; cultivation, maintenance, and preservation of pure cultures.

Unit – 4: Aim and principles of classification, systematics, and taxonomy, the concept of species, taxa, strain; conventional, molecular, and recent approaches to evolutionary chronometers, rRNA oligonucleotide sequencing, and its importance. Differences between eubacteria and archaea. General characteristics, phylogenetic overview of bacteria and archaea. Introduction to Proteobacteria, Firmicutes, *Nanoarchaeota (Nanoarchaeum)*, *Thermoproteota (Sulfolobus)*, and *Euryarchaeota (Methanobacterium, Halococcus)*.

Practical

1) Staining: Gram-negative and Gram-positive bacteria: characteristics and examples. Study of typical eubacteria (*Bacillus, Clostridium, Staphylococcus, Streptococcus, Escherichia*); simple staining, negative staining, acid-fast staining, Capsule staining, Endospore staining; Motility by hanging drop method.
2) Preparation of different media: synthetic media, complex media - Nutrient agar, McConkey agar, EMB agar. Preparation of culture media (liquid & solid) for bacterial cultivation.
3) Handling and care of laboratory equipment - autoclave, hot air oven, incubator, and laminar airflow; Sterilization of media using autoclave and assessment of sterility.
4) Sterilization of glassware using a hot air oven. Sterilization of heat-sensitive material by membrane filtration.
5) Isolation & Estimation of pure cultures of bacteria by streaking method, CFU count by spread plate method/pour plate method.
6) Preservation of bacterial cultures by various techniques. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

Reference Books:

1. Prescott MJ, Harley JP, Klein DA. Microbiology. 5th Edition WCB McGraw-Hill, New York, (2002).
2. Tortora GJ, Funke BR, Case CL. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
3. Alcomo IE. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
4. Black JG. Microbiology - Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
5. Besty T, Koegh J. Microbiology Demystified. McGraw-Hill (2005).
6. Ray A, Mukherjee R. Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology. Taurean Publications, India.

Course Name: Microbial World and Principles of Microbiology Course Code: BSCMCBSE101					
Course Type: **SE (Practical)**	Course Details: **SEC -1**			L-T-P: **0 - 1 - 4**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30		**20**	

***Instructions*: Continuous assessment (CA) of this course should include a written test with questions from the principle portions.**

Course Learning Outcomes:

After the completion of the course, the students will be able to:

- Develop a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
- Develop a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these, and basic tools to study these in the laboratory.
- Able to explain the useful and harmful activities of the microorganisms.
- Able to perform basic experiments to grow and study microorganisms in the laboratory.
- Identify commonly available fungi and algae and their characteristics. Discuss how fungi and algae are used as biofertilizers in agriculture and as biopesticides.

Course Content:

Unit – 1: ***Principle:*** Binomial nomenclature, Whittaker's five kingdoms, and Carl Woese's three-domain classification systems and their utility. General characteristics of cellular microorganisms, wall-less forms - MLO (mycoplasma and spheroplasts) with emphasis on distribution and occurrence - chlamydia and rickettsia, Fundamentals of viral structure and its importance.

Practical: Identification of unknown bacterial isolates based on morpho-physio-biochemical characters using Bergey's manual.

Unit – 2: ***Principle:*** General concept of phytoplankton and zooplankton. General characteristics, structure, mode of reproduction, and economic importance of actinomycetes. General characteristics, occurrence, structure, reproduction, and importance of protozoa.

Practical: (1) Simple staining of protozoa. (2) Hay culture to study *Paramoecium*. Identification of *Amoeba, Entamoeba, Plasmodium*.

Unit – 3: ***Principle:*** Characteristics, classification, and cellular and thallus organization of fungi. General features, structure, nutrition, reproduction of different fungal phylum - Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, and Deuteromycota. Role of fungi in biotechnology. Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoprotein); Secondary metabolites (Pharmaceutical preparations, red-penciling); Agriculture (Biofertilizers, eg.- VAM); Mycotoxins; Biological control (Mycoinsecticides). Mushroom and its cultivation.

Practical: (1) Isolation and cultivation of fungi from natural sources. (2) Simple staining of fungi. (3) Lab-scale preparation of spawn and cultivation of mushrooms. (4) Study of the vegetative and reproductive structures of the following genera through temporary or permanent slides - *Mucor, Saccharomyces, Rhizopus, Penicillium, Aspergillus.*

Unit – 4: ***Principle:*** General characteristics of algae. Occurrence, thallus organization, algae cell

ultrastructure - pigments, flagella, eye-spot, food reserves; vegetative, asexual, and sexual reproduction. Classification of algae by Robert Edward Lee (2008) and economic importance. Mass cultivation of algae as a source of protein.

Practical: (1) Enumeration of Yeast by using a haemocytometer. (2) Study of the vegetative and reproductive structures of the following genera through temporary or permanent slides - *Spirogyra, Chlamydomonas, Volvox*.

Reference Books:

1. Prescott MJ, Harley JP, Klein DA. Microbiology. 5th Edition WCB McGraw-Hill, New York, (2002).
2. Tortora GJ, Funke BR, Case CL. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
3. Alcomo IE. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
4. Black JG. Microbiology - Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
5. Besty T, Koegh J. Microbiology Demystified. McGraw-Hill (2005).
6. Ganguly KK. Science and Technology, History and Evolution. Chapter - History of Microbiology, July 2020, pp. 221 -237, Publisher: Kumud Publications, ISBN:978-81-945060-3-4.
7. Ray A, Mukherjee R. Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology. Taurean Publications, India.

Semester – 2

Course Name: Biochemistry Course Code: BSCMCBMJ201					
Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-2**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

and

Course Name: Biochemistry Course Code: BSCMCBMN201					
Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-2**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

Course Learning Outcomes:

By the end of this course the students will -

- Develop a very good understanding of various biomolecules which are required for the development and functioning of a bacterial cell.
- Understand how carbohydrates make the structural and functional components such as energy generation and storage of food molecules for the bacterial cells
- 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.
- Able to make buffers, study enzyme kinetics, and calculate Vmax, Km, Kcat values.

Course Content:

Theory

Unit – 1: Concept of bio-molecules - Building blocks of life, Macromolecules. Basic concept on the structure of water molecule, forces in molecules. Concept of pH and buffers and numerical problems to explain the concepts.

Concept of bioenergetics - first and second laws of thermodynamics. Definitions of Gibb's free energy, enthalpy, and 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, ATP.

Unit – 2: Carbohydrate: Basic idea on carbon atom structure. Stereo isomerism of monosaccharides, epimers, mutarotation, and anomers of glucose. Families of monosaccharides – aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, sugar derivatives, and glucosamine. Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, sucrose, polysaccharides, storage polysaccharides, starch, and

glycogen. Structural polysaccharides, cellulose, peptidoglycan, and chitin.

Unit – 3: Protein: Amino acids as the building blocks of proteins. Titration curve of amino acid and its Significance, Classification, biochemical structure, and notation of standard protein amino acids Ninhydrin reaction. General formula of amino acid and concept of zwitterion. Natural modifications of amino acids in proteins hydrolysine, cystine, and hydroxyproline, non-protein amino acids: Gramicidin, beta-alanine, D-alanine, and D-glutamic acid. Primary, secondary, tertiary, and quaternary structures. Enzymes: General concept of enzyme, Apoenzyme, and cofactors, prosthetic group - TPP, coenzyme - NAD, metal cofactors, Classification of enzymes (IUBMB), Mechanism of action of enzymes: active site, transition state complex, and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism. Definitions of terms – enzyme unit, specific activity and turnover number, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive - heavy metal salts and Uncompetitive. Feedback inhibition. Cooperativity.

Unit – 4: Lipids: Definition and major classes of storage and structural lipids. Storage-lipids. Fatty acid's structure and functions. Essential fatty acids. Triacylglycerols structure, functions, and properties. Saponification, Iodine number. Structural lipids. Phosphoglycerides: Building blocks, general structure, functions, and properties. Structure of phosphatidylethanolamine and phosphatidylcholine. Sphingolipids: building blocks, the structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides, and gangliosides. Lipid functions: cell signals, cofactors, prostaglandins, Introduction to lipid micelles, monolayers, bilayers, liposome.

Unit – 5: Nucleic acids and vitamins: Base composition: Purine, pyrimidine bases, nucleoside, nucleotide - structure, properties. Types, structure, and function of DNA & RNA. Model of DNA structure. Superhelicity in DNA, linking number, topological properties. Vitamin: Classification and characteristics with suitable examples, sources, and importance.

Practical

1) Preparation of buffer - Phosphate buffer, Tris buffer.
2) Qualitative/Quantitative tests for carbohydrates, reducing sugars (DNS), and non-reducing sugars (Anthrone).
3) Qualitative/quantitative tests for amino acid (Ninhydrin), and protein (Lowry).
4) Qualitative tests for lipids - Sudan.
5) Study of enzyme kinetics – calculation of Vmax, Km, Kcat values.
6) Study the effect of temperature and pH on enzyme activity.
7) Estimation of vitamin - Ascorbic acid.

Reference Books:

1. Tortora GJ, Funke BR, Case CL. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
2. Stanbury, Biochemistry
3. Voet & Voet. Fundamentals of Biochemistry. Wiley
4. Cox MM, Nelson DL. Lehninger's principles of biochemistry. WH Freeman
5. Stryer. Biochemistry WH Freeman
6. Jain JL, Jain S, Jain N. Fundamentals of Biochemistry. S. Chand (2016).

Course Name: Microbial Techniques and Instrumentation Course Code: BSCMCBSE201					
Course Type: **SE (Practical)**	Course Details: **SEC -2**			L-T-P: **0 - 1 - 4**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30		**20**	

Instructions: **Continuous assessment (CA) of this course should include a written test with questions from the principle portions.**

Course Learning Outcomes:

By the end of this course the students will -

- Understand principles that underlie sterilization of culture media, glassware, and plastic ware to be used for microbiological work.
- Understand principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.
- Learned handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced to a variety of modifications in the microscopes for specialized viewing.
- Understand several separation techniques which may be required to be handled by microbiologists.

Course Content:

Theory

Unit – 1: ***Principle:*** Microscopy- Principle, mechanism, and application of photo-optical instruments (different types of microscopes), Phase contrast microscope, Bright field microscope, Dark field microscope, Fluorescence microscopy, Confocal microscopy, Scanning and transmission electron microscopy, Expansion microscopy, Micrometry.

Practical: (1) Ray diagrams of phase contrast microscopy and electron microscopy. (2) Measurement of a microscopic object using an ocular micrometer and stage micrometer.

Unit – 2: ***Principle:*** Purification and separation techniques: Principle and techniques with applications (partition, adsorption, ion exchange, size exclusion, 2-D, HPLC, GLC, and affinity chromatography). Electrophoretic technique (agarose and polyacrylamide gel) its components, working, and applications. Principles of centrifugation and ultracentrifugation techniques and their applications. The basic idea of salting out, and dialysis.

Practical: (1) Separation of mixtures by paper/ thin layer chromatography - Amino acid, Sugar; Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE); (2) Separation of components of a given mixture using a laboratory scale centrifuge; (3) Understanding density gradient centrifugation with the help of pictures.

Unit – 3: ***Principle:*** Biophysical principles: Osmosis, osmotic pressure, Donan equilibrium, diffusion potential, diffusion coefficient, endocytosis & exocytosis, the gradient of chemical potential as driving force in transport, membrane potential & ionophores.

Practical: Demonstration of the protoplast formation using lysozyme.

Unit – 4: ***Principle:*** Principle, mechanism, and application of instruments used in spectrophotometric techniques (UV visible, IR, Fluorescence, NMR, ESR). The basic concept of CD, ORD. Radioactivity: Laws of radioactivity, half-life & average life, types of radiation (α, β, γ radiations)

application of radioactive isotopes in biology. Radioisotope dilution technique and autoradiography.

Practical: Spectrophotometric determination of DNA/RNA concentration and its purity checking without and chromogenic reaction.

Reference Books:

1. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th Edition. Cambridge University Press (2000).
2. Murphy DB. Fundamental of Light Microscopy & Electron Imaging. 1st Edition. Wiley-Liss. (2001).
3. Ghatak KL. Techniques and Methods: In Biology. PHI Publication (2011).
4. Kumar P. Fundamentals and Techniques of Biophysics and Molecular Biology (2016).
5. Blair A. Laboratory Techniques & Experiments: In Biology. Intelliz Press
6. Plummer DT. An Introduction to Practical Biochemistry. McGraw Hill Publication (1987).
7. Beckner WM, Kleinsmith LJ, Hardin J. The world of cells. IV edition. Benjamin Cummings (2000).
8. Upadhyay, Upadhyay, Nath. Biophysical Chemistry. Himalaya Publishing House.

Semester - 3

Course Name: Cell Biology Course Code: BSCMCBMJ301					
Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-3**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

Course Learning Outcomes:

By the conclusion of this course, students will be capable of –

- Describing the structure and function of different components of a cell.
- Differentiating the cellular and molecular processes between prokaryotes and eukaryotes.

Course Content:

Theory

Unit – 1: Concepts of cell - Comparison of Prokaryotic & Eukaryotic cells. Eukaryotic cell organelles - structure and function. Eukaryotic cells - cell wall & plasma membrane; Eukaryotic cell wall, extracellular matrix, and cell-matrix interactions, cell-cell interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects).

Unit – 2: Cytoskeleton: Structure and organization of actin filaments, microtubules. Nuclear envelope, nuclear pore complex, and nuclear lamina. Chromatin structure – Molecular organization, Nucleolus.

Unit – 3: Eukaryotic cell cycle and its regulation, Mitosis and Meiosis. Development of cancer, programmed cell death. The basic idea of stem cells and pluripotency.

Unit – 4: Basic idea and function of signalling molecules and their receptors. Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase, JAK-STAT, Integrin pathway.

Unit – 5: Protein sorting and transport - targeting and insertion of proteins in the ER, protein folding and processing, role of chaperones in protein folding, export of proteins and lipids. Protein glycosylation, sorting, and export from Golgi apparatus, and Lysosomes. Outline idea of protein turnover.

Practical

1) Microscopic study of a eukaryotic cell.
2) Study of polyploidy through permanent slide.
3) Study of mitotic index in onion/garlic root tip.
4) Electron microscopic study of cellular ultrastructure. (video/photomicrographs)
5) Identification and study of cancer cells. (video/photomicrographs)
6) Demonstration of the presence of mitochondria in striated muscle cells.
7) Study of epithelial cells.

Reference Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell, 4th Edition. Garland Publishing Inc. (2002).
2. Darnell, Lodish, Baltimore. Molecular Cell Biology, Scientific American Publishing Inc. (2000). Increase book references

Course Name: Molecular Biology **Course Code: BSCMCBMJ302**					
Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-4**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

Course Learning Outcomes:

By the conclusion of this course, students will be capable of –

- Describing the importance and mechanism of the central dogma of life
- Differentiating the cellular and molecular processes between prokaryotes and eukaryotes.

Course Content:

Theory

Unit – 1: Structures of Genetic Material: Types of genetic material, denaturation, and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA in Prokaryotes, Eukaryotes, Viruses, mitochondria, and chloroplast.

Unit – 2: Replication of DNA (Prokaryotes and Eukaryotes): Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication Mechanism of DNA replication: Enzymes and other accessory protein involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase (for replication of linear ends). Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication.

Unit – 3: Transcription in Prokaryotes and Eukaryotes: Transcription: Definition, the difference from replication, promoter - concept, and strength of promoter RNA polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general transcription factors. Post-transcriptional processing: Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, the concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, Mode of action of transcription inhibitors, RNA interference: siRNA, miRNA, and its significance.

Unit – 4: Translation (Prokaryotes and Eukaryotes): Translational machinery, Ribosome: ultrastructure and assembly, charging of tRNA, aminoacyl-tRNA synthetases, Mechanisms of initiation, elongation, and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation. Mode of action of translation inhibitors.

Unit –5: Regulation of Gene Expression in Prokaryotes and Eukaryotes: Principles of transcriptional regulation. Regulation in *lac* and *trp* operons, Sporulation in *Bacillus*. Epigenetic changes in chromatin structure - DNA methylation and Histone acetylation mechanisms.

Practical

1) Study of different types of DNA and RNA using video/pictorial 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* and checking of its purity (A260/280).
4) Estimation of salmon sperm/calf thymus DNA using UV spectrophotometer (A260 measurement).
5) Estimation of DNA and RNA using diphenylamine and orcinol reagent, and UV spectrophotometer (A260 measurement).
6) Separation and visualization of DNA by Agarose Gel Electrophoresis.
7) Extraction, Separation, and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Reference Books:

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland Publishing Inc. (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson JD, Baker. TA, Bell SP, Gann A, Levine M, Losick R. Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
5. Brown TA. Gene Cloning and DNA analysis. 2nd Edition, A S Mpress. (2004).
6. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
7. Glick BR. Pasternak JJ. Molecular Biotechnology, 2nd Ed.ASM press. (2003).

<table>
<tr><td colspan="6">Course Name: Fundamentals of Molecular Biology
Course Code: BSCMCBMN301</td></tr>
<tr><td colspan="2">Course Type:
Minor (Theoretical & Practical)</td><td colspan="2">Course Details: MNC-3</td><td colspan="2">L-T-P: 3 - 0 - 4</td></tr>
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100</td><td colspan="2">CA Marks</td><td colspan="2">ESE Marks</td></tr>
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<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
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Course Learning Outcomes:

By the conclusion of this course, students will be capable of –

- Describing the importance and mechanism of the central dogma of life
- Differentiating the cellular and molecular processes between prokaryotes and eukaryotes.

Course Content:

Theory

Unit – 1: Structures of Genetic Material: Types of genetic material, different models of DNA structure, salient features of the double helix, types of DNA, denaturation, and renaturation, cot curves.

Unit – 2: Replication of DNA (Prokaryotes and Eukaryotes): Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication.

Unit – 3: Transcription in Prokaryotes and Eukaryotes: Transcription: Definition, the difference from replication, promoter - concept, and strength of promoter, RNA polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general transcription factors.

Unit – 4: Translation (Prokaryotes and Eukaryotes): Translational machinery, charging of tRNA, aminoacyl-tRNA synthetases. Mechanisms of initiation, elongation, and termination of polypeptides in both prokaryotes and eukaryotes.

Unit –5: Regulation of Gene Expression in Prokaryotes and Eukaryotes: Principles of transcriptional regulation. Regulation in *lac* and *trp* operons. Epigenetic changes in chromatin structure - DNA methylation and Histone acetylation mechanisms.

Practical

1) Isolation of genomic DNA from *E. coli*.
2) Estimation of salmon sperm/calf thymus DNA using a colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement).
3) Separation and visualization of DNA by Agarose Gel Electrophoresis.
4) Separation and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Reference Books:

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland Publishing Inc. (2002).
3. Darnell, Lodish, Baltimore. Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
5. Brown TA. Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
6. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
7. Glick BR, Pasternak JJ. Molecular Biotechnology, 2nd Ed. ASM press. (2003).

Semester - 4

<table>
<tr><td colspan="5">Course Name: Microbial Diagnostics and Public Health
Course Code: BSCMCBMJ401</td></tr>
<tr><td>Course Type:
Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-5</td><td colspan="2">L-T-P: 3 - 0 - 4</td></tr>
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<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
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Course Learning Outcomes:

By the conclusion of this course, the students will -

1) Developed a good understanding of practical aspects of the collection of different clinical samples, their transport, culture, and examination by staining, and molecular and immunological diagnostic methods for diagnosis of microbial diseases.
2) Developed an excellent understanding of practical aspects of antibiotic sensitivity testing, water and food testing skills using kits available in the market.

Course Content:

Theory

Unit – 1: Importance of diagnosis of diseases: Bacterial, Viral, Fungal, and Protozoan diseases of various human body systems, Disease-associated clinical samples for diagnosis.

Unit – 2: Collection of clinical samples: How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine, and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit – 3: Direct microscopic examination and culture. Examination of the sample by staining - Gram stain, Ziehl-Neelsen 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: Serological methods - Agglutination, ELISA, immunofluorescence; Nucleic acid-based methods - PCR, Nucleic acid probes. Kits for rapid detection of pathogens: Typhoid, Dengue and HIV, Swine flu.

Unit – 5: Testing for antibiotic sensitivity in bacteria: 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.

Practical

1) Isolation of bacteria in pure culture and antibiotic sensitivity.
2) Identification of common bacteria (*E. coli, Staphylococcus aureus*, and *Streptococcus* sps.) by studying their morphology, cultural character, biochemical reactions, and other tests.
3) Maintenance and preservation of stock culture.

Reference books:

1. Ananthanarayan R, Paniker CKJ. Textbook of Microbiology. 7 Press Publication. (2005).
2. Prescott's Microbiology, Authors Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton, Publisher McGraw-Hill (2011).

Course Name: Industrial Microbiology **Course Code: BSCMCBMJ402**					
Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-6**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

Course Learning Outcomes:

By the conclusion of this course, the students will -

1) Be capable of describing a large number of substrates that are used for the industrial fermentation processes.
2) Developed an understanding of different types of reactors or fermenters which are used for laboratory, pilot, and industrial scale fermentations and their process parameters.
3) Acquired a detailed knowledge of several products that are produced by industrial fermentation processes.

Course Content:

Theory

Unit – 1: 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, sulfite waste liquor, whey, yeast extract, and protein hydrolysates.

Unit – 2: Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (e.g., Baker's yeast), and continuous fermentations. Components of a typical bioreactor, 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 – 3: Downstream processing; Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization, and spray drying. Microbial cells as food. SCP - mushroom cultivation.

Unit – 4: Microbial production of industrial products (microorganisms involved, media, fermentation conditions, downstream processing, and uses) - Citric acid, ethanol, penicillin, glutamic acid, Vitamin B_{12}. Enzymes (amylase) wine, beer.

Unit – 5: Methods of immobilization, advantages, and applications of immobilization, large-scale applications of immobilized enzymes (glucose isomerase). Role of microbes in medicine and textile industry.

Practical

1) Demonstrate different parts of the fermenter.
2) Microbial fermentations for the production and estimation (qualitative and quantitative) of:
   (a) Enzymes: Amylase
   (b) Amino acid: Glutamic acid
   (c) Alcohol: Ethanol
3) A visit to any industry or production center related to microbiology, prepare a report on the entire visit. *(Mandatory for all students of all colleges unless there is any severe health issue)*. College-industry certification.

Reference Books:

1. Reed G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).
2. Demain AL. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
3. Waites MJ, Morgan NL, Rockey JS, Higton G. Industrial Microbiology: An introduction. Blackwell Science Publishers (2002).
4. Casida LE. Industrial Microbiology, J. Wiley, (1968).
5. Pelczar MJ, Chan ECS, Krieg NR. Microbiology, McGraw-Hill.
6. Willey, Sherwood, Woolverton. Prescott, Harley and Klein's Microbiology. McGraw-Hill Publ.
7. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cummings.

Course Name: Microbial Physiology and Metabolism **Course Code: BSCMCBSE401**					
Course Type: **SE (Practical)**	Course Details: **SEC - 3**			L-T-P: **0 - 1 - 4**	
Credit: **3**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30		**20**	

***Instructions*: Continuous assessment (CA) of this course should include a written test with questions from the principle portions.**

Course Learning Outcomes:

By the conclusion of this course, the students will be capable of-

1) Describing the growth characteristics of the microorganisms capable of growing under the unusual environmental conditions of temperature, oxygen, and solute and water activity.
2) Describing the growth characteristics of the microorganisms that require different nutrients for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemolithoautotrophs, etc.
3) Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.

Course Content:

Unit – 1: ***Principle:*** Definitions of growth, measurement of microbial growth, Phases of growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, and diauxic growth curve. Microbial growth in response to the environment - Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermoduric, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

Practical: (1) Study and plot the growth curve of *E. coli* by turbidometric. (2) Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data

Unit – 2: ***Principle:*** Microbial growth in response to nutrition and energy – Autotroph/ phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, Photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport Group translocation, Iron uptake.

Practical: (1) Effect of temperature on growth of *E. coli*, (2) Effect of pH on growth of *E. coli*. (3) Effect of salt on the growth of *E. coli*.

Unit – 3: ***Principle:*** Concept of aerobic metabolism, anaerobic metabolism, and fermentation - Sugar degradation pathways i.e., EMP, ED, Pentose phosphate pathway, TCA cycle. Electron transport chain: components of the respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers, and inhibitors. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways). Account of beta-oxidation of even and odd numbers, saturated and unsaturated fatty acids.

Practical: Demonstration of alcoholic fermentation.

Unit – 4*:* ***Principle:*** Introduction to aerobic and anaerobic chemolithotrophy with an example of 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.

Practical: Demonstration of the thermal death time and thermal death point of *E. coli*.

Unit – 5: ***Principle:*** Anaerobic respiration with special reference to dissimilatory nitrate. Reduction (denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Concept & mechanism of biological nitrogen fixation, Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification. Concept and reaction of transamination, deamination, transmethylation and decarboxylation, Urea cycle in connection to amino acid catabolism.

Practical: Effect of deprivation of carbon and nitrogen sources on growth of *E. coli*.

Reference Books:

1. Voet & Voet. Fundamentals of Biochemistry Wiley
2. Cox MM, Nelson DL. Lehninger's principles of biochemistry. WH Freeman
3. Stryer. Biochemistry. WH Freeman
4. Jain JL, Jain S, Jain N. Fundamentals of Biochemistry. (2016) S. Chand
5. Madigan, Martinko, Bender, Buckley, Stahl. Brock Biology of Microorganisms. Pearson
6. Prescott MJ, Harley JP, Klein DA. Microbiology. 5th Edition WCB McGraw-Hill, New York.

Course Name: Public Health and Microbial Diagnostics Course Code: BSCMCBMN401					
Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-4**			L-T-P: **3 - 0 - 4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

Course Learning Outcomes:

By the conclusion of this course, the students will -

1) Developed a good understanding of practical aspects of the collection of different clinical samples, their transport, culture, and examination by staining, as well as molecular and immunological diagnostic methods for the diagnosis of microbial diseases.
2) Developed an excellent understanding of practical aspects of antibiotic sensitivity testing, water and food testing skills using kits available in the market.

Course Content:

Theory

Unit – 1: Importance of diagnosis of diseases: Bacterial, Viral, Fungal, and Protozoan diseases of various human body systems, Disease-associated clinical samples for diagnosis.

Unit – 2: Collection of clinical samples: How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine, and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit – 3: Direct microscopic examination and culture. Examination of the sample by staining-Gram stain, Ziehl-Neelsen 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: Serological methods - Agglutination, ELISA, immunofluorescence, Nucleic acid-based methods - PCR, Nucleic acid probes. Kits for rapid detection of pathogens: Typhoid, Dengue and HIV, Swine flu.

Unit – 5: Testing for antibiotic sensitivity in bacteria: 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.

Practical

1) Isolation of bacteria in pure culture and Antibiotic sensitivity.
2) Identification of common bacteria (*E. coli, Staphylococcus aureus,* and *Streptococcus* sps.) by studying their morphology, cultural character, Biochemical reactions, and other tests.
3) Maintenance and preservation of stock culture.

Reference books:

1. Ananthanarayan R, Paniker CKJ. Textbook of Microbiology. 7 Press Publication. (2005).
2. Prescott MJ, Harley JP, Klein DA. Microbiology. 5th Edition WCB McGraw-Hill, New York.