NATIONAL CURRICULUM AND CREDIT FRAMEWORK (NCCF)

Syllabus

B.SC. MICROBIOLOGY /
B.SC. MICROBIOLOGY (HONOURS)

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

Kazi Nazrul University

Asansol, Paschim Bardhaman
West Bengal 713340

Detailed Syllabus

Semester - 1

Course Name: Microbial World and Principles of Microbiology

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**

Course Learning Outcomes:

After the completion of the course, the students will:

- *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:

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.

Unit – 2: Binomial nomenclature, Whittaker's five kingdom, 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.

Unit – 3: General concept of phytoplanktons and zooplanktons. General characteristics, structure, mode of reproduction, and economic importance of actinomycetes. General characteristics, occurrence, structure, reproduction, and importance of protozoa.

Unit – 4: Characteristics, classification, and cellular & 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.

Unit – 5: 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) Good Laboratory Practices and Biosafety in Microbiology.
2) Study the basic principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3) Study of the vegetative and reproductive structures of the following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus*, and *Alternaria*.
4) Lab-scale preparation of spawn and cultivation of mushrooms.
5) Study of microbes using temporary/permanent mounts - *Rhizopus, Penicillium, Aspergillus, Spirogyra, Chlamydomonas, Volvox, Amoeba*.

Reference Books:

1. Prescot, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB McGrawHill, New York, (2002).
2. Ganguly, K.K. Science and Technology, History and Evolution. Chapter-History of Microbiology, July 2020, pg: 221 -237, Publisher: Kumud Publications, ISBN:978-81-945060-3-4.

Course Name: Microbial World and Principles of Microbiology

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 Content same as BSCMCBMJ101

Course Name: Bacteriology

Course Code: BSCMCBSE101

Course Type: **SEC (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**	

Course Learning Outcomes:

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

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

Course Content:

Unit – 1:

Principle: 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.

Practical: Staining: Gram-negative and Gram-positive bacteria: characteristics and examples. Study of typical eubacteria (Bacillus, Clostridium, Staphylococcus, Streptococcus, Mycobacterium, Escherichia); simple staining, negative staining, and acid-fast staining, Capsule staining, Endospore staining; Motility by hanging drop method.

Unit – 2:

Principle: 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.

Practical: Preparation of different media: synthetic media, complex media- Nutrient agar, McConkey agar, EMB agar. Preparation of culture media (liquid & solid) for bacterial cultivation;

Unit – 3:

Principle: 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.

Practical: Handling and care of laboratory equipment - autoclave, hot air oven, incubator, and laminar airflow; Sterilization of media using autoclave and assessment of sterility. Sterilization of glassware using a hot air oven. Sterilization of heat-sensitive material by membrane filtration. Isolation & Estimation of pure cultures of bacteria by streaking method, CFU count by spread plate method/pour

plate method. Preservation of bacterial cultures by various techniques. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.

Unit – 4:

Principle: 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: Identification of unknown bacterial isolate on the basis of morpho-physio-biochemical characters using Bergey's manual.

Reference Books

1) Prescott, M.J., Harley, J.P. and Klein, D.A. Microbiology. 5th Edition WCB McGrawHill, 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) Ray A. and 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**

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 as 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, 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), non-reducing sugars (Anthrone).
3. Qualitative/Quantitative tests for amino acid (Ninhydrin), 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, pH on enzyme activity.
7. Estimation of vitamin - Ascorbic acid.

Reference Books:

1. Tortora, G.J., Funke, B.R and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
2. Stanbury, Biochemistry
3. Voet & Voet. Fundamentals of Biochemistry. Wiley
4. M.M. Cox, D.L. Nelson. Lehninger's principles of biochemistry. WH Freeman
5. Stryer. Biochemistry WH Freeman
6. Fundamentals of Biochemistry (2016) by J L Jain, Sanjay Jain, Nitin Jain. S. Chand

Course Name: Biochemistry

Course Code: BSCMCBMN201

<table>
<tr><td>Course Type:
Minor (Theoretical & Practical)</td><td colspan="2">Course Details: MNC-2</td><td colspan="2">L-T-P: 3 - 0 - 4</td></tr>
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<tr><td>Practical</td><td>Theoretical</td><td>Practical</td><td>Theoretical</td></tr>
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Course Content same as BSCMCBMJ201

Course Name: Microbial Techniques and Instrumentation

Course Code: BSCMCBSE201

Course Type: **SEC (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**	

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: Ray diagrams of phase contrast microscopy and Electron microscopy. Measurement of a microscopic object using an occular 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, Dialysis.
Practical: Separation of mixtures by paper/ thin layer chromatography - Amino acid, Sugar; Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE); Separation of components of a given mixture using a laboratory scale centrifuge; 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 D.B. Fundamental of Light Microscopy & Electron Imaging. 1st Edition. Wiley-Liss. (2001).
3. K L Ghatak. Techniques And Methods: In Biology PHI Publication (2011)
4. Pranav Kumar. Fundamentals and Techniques of Biophysics and Molecular Biology (2016).
5. Aurora Blair. Laboratory Techniques & Experiments: In Biology. Intelliz Press
6. D.T Plummer. An Introduction to Practical Biochemistry. McGraw Hill Publication 1987
7. Beckner, W.M., Kleinsmith L.J and Hardin J. The world of cell. IV edition. Benjamin Cummings (2000)
8. Biophysical Chemistry by Upadhyay, Upadhyay, Nath. Himalaya Publishing House.