BIDHANNAGAR COLLEGE

GOVERNMENT OF WEST BENGAL

AFFILIATED TO WEST BENGAL STATE UNIVERSITY

P.G. DEPARTMENT OF MICROBIOLOGY

Syllabus for M.Sc. Course in Microbiology

(From Academic Session 2022-23)

Bidhannagar College, Affiliated to West Bengal State University
P.G. Department of Microbiology

Draft Syllabus for Two Year Post Graduate Course of Microbiology
Under Choice Based Credit System (CBCS)

(With effect from the Academic Session 2022-2023)

The new syllabus for the M. Sc. Course in Microbiology of Bidhannagar College would commence from July, 2022 (2022 – 2023 Academic Session). The following are the rules and regulations for the Two-year M. Sc. Course in Microbiology:

1. The college is affiliated to West Bengal State University (W.B.S.U), Barasat, District North 24 Parganas, which would award the M. Sc. Degree.
2. A candidate who has passed the three year B.Sc. Examination with Microbiology Honours from the W.B.S.U would be eligible to apply for admission to this course following the guidelines of the UGC and Govt. of West Bengal. A limited number of seats would be offered to eligible students of other Universities as per existing rules of the Dept. of Higher Education, Govt. of West Bengal.
3. The Post-Graduate Department of Microbiology, Bidhannagar College exercises academic autonomy for the postgraduate courses. Under the system of academic autonomy, Board of Studies for Post-Graduate (PGBOS) studies in Microbiology exists to provide necessary guidance in matters of syllabus formulation, appointment of examiners, publication of results and any other problem pertaining to the Post-graduate course in Microbiology.
4. The Post-graduate course in Microbiology would be conducted in English language only.
5. The duration of the course would be two academic years and the examination for the M.Sc. degree in Microbiology would be held through four semesters over a total 1200 marks. The duration of the semesters would be as follows:

Semester - Odd	**Semester - Even**
Semester – I (July – December)	Semester – II (January – June)
Semester – III (July – December)	Semester – IV (January – June)

6. A candidate pursuing the M.Sc. course in Microbiology would be considered eligible for appearing in the examination provided he /she prosecutes regular course of studies in Microbiology maintaining the minimum percentage of attendance in both theory and practical classes, as notified by the college / university time to time.

EXAMINER: Paper setters, moderators, examiners, and scrutinizers for each paper will be appointed on the recommendations of the Board of Post Graduate studies in the concerned subject. Scripts will be examined by single/multiple examiner(s) for all theory papers and double/multiple (internal and external) for all practical papers, dissertation, viva voce etc.

The proposed Structure of PG Course Content in Microbiology as per CBCS guideline

Semester	Paper	Theory/ Practical	Title of the Paper	Paper Full Marks	Paper Credit
Semester 1	MCBT101	Theory	Biomolecules & Enzymes	50	4
	MCBT102	Theory	Basic Microbiology & Cell biology	50	4
	MCBT103	Theory	Biophysical Techniques	50	4
	MCBP101	Practical	Biomolecules & Enzymes	50	4
	MCBP102	Practical	Basic Microbiology	50	4
	MCBAECC	Theory	Laboratory Safety Measures & Intellectual Property Rights	50	2
	TOTAL			**300**	**22**
Semester 2	MCBT201	Theory	Metabolism & Bioenergetics	50	4
	MCBT202	Theory	Fundamentals of Molecular Biology	50	4
	MCBT203	Theory	Recombinant DNA Technology (RDT)	50	4
	MCBP201	Practical	Molecular Biology & RDT	50	4
	MCBP202	Practical	Environmental Microbiology	50	4
	MCBSEC	Theory	Environmental Microbiology	50	2
	TOTAL			**300**	**22**
Semester 3	MCBT301	Theory	Microbial Genetics	50	4
	MCBT302	Theory	Virology	50	4
	MCBT303	Theory	Immunology	50	4
	MCBDSE01/ MCBDSE02	Theory	Bioprocess Technology/ Industrial & Food Microbiology	50	4
	MCBP301	Practical	Immunology & Virology	50	4
	MCBP302	Practical	Industrial & Food Microbiology	50	4
	MCBGEC	Theory	Basic and Applied Microbiology	50	4
	TOTAL			**350**	**28**
Semester 4	MCBT401	Theory	Medical Microbiology	50	4
	MCBDSE03/ MCBDSE04	Theory	Developmental & Evolutionary Biology/ Advance Biotechnology	50	4
	MCBP401	Practical	Bioinformatics & Biostatistics	50	4
	MCBP402	Practical	Project Seminar & Grand Viva	100	8
	TOTAL			**250**	**20**
TOTAL (4 SEMESTERS)				**1200**	**92**

Question Pattern and Marks Distribution

A. Core Subjects : Compulsory for all.

B. Elective Subjects : Student will choose any two of the four Elective subjects being offered.

C. Choice Based Credit Course : Student will choose any one of the CBCCs being offered.

D. Division of Theoretical Marks

1. Theoretical of 50 marks : 40 (Theoretical) + 10 (Internal Assessment)

40 (Theoretical) = 10 MCQ of 1 mark each + 5 questions of 6 marks each.

10 (Internal Assessment) = 5 short question of 2 marks each.

E. Division of Practical Marks

1. Practical of 50 marks : 30 (Internal Assessment) + 20 (Viva-voce)

2. Project Work/ Review of 50 marks : 30 (Work) + Presentation (10) + Interaction (10)

F. Grand Viva : 50

G. Attendance will be consider along with the Internal Marks

Attendance requirement

No student shall be considered to have pursued a regular course of study unless he/she is certified by the Head of the Department of Microbiology to have attended 75% of the total number of lectures and practical course conducted in each semester, during his/her course of study. Provided that he/she fulfils other conditions, the Head, Department of Microbiology, may permit a student to the next Semester who falls short of the required percentage of attendance by not more than 10% of the lectures and practical course conducted during the Semester.

Gradation of students' performance

Marks 50 Credit 4	Marks 100 Credit 8	Grade Point Scale	Grades	Letter Grade	CLASS
40-50	80-100	10	Outstanding	O	1ST
35-39	70-79	9	Excellent	A+	1ST
30-34	60-69	8	Very Good	A	1ST
28-29	55-59	7	Good	B+	1ST
25-27	50-54	6	Fair	B	2ND
23-24	45-49	5	Average	C	2ND
20-22	40-44	4	Poor	D	3RD
19 and less	39 and less	Below 4	Fail	F	

Grade Point Scale

It is a *Grade Point Scale* (GPS) ranging from 0 (zero) to 10 (ten) where the maximum attainable grade point is 10 and any grade point obtained below 4 represents fail. The values in the Grade Point scale would be representative of the range of percentage of marks obtained, Grade, Letter Grade and Class in a particular paper in a given Semester Examination as depicted in the Table above.

Credit Point

For a particular paper in a given semester, *Credit Point* is defined as the factor of Grade Scale point obtained (according to the percentage of marks obtained) and Maximum Credit Point allotted to the concerned paper.

Summation of Grade Point Average (SGPA)

For a particular semester, *Summation of Grade Point Average (SGPA)* is defined as the quotient of the summation of Credit Points Obtained (CPO) to summation of Maximum Credit Points (MCP) multiplied with Maximum Grade Point Scale.

.e SGPA = Σ (CPO/MCP) X Grade Point Scale (10)

Cumulative of Grade Point Average (CGPA)

For a particular semester, *Cumulative Grade Point Average (CGPA)* is defined as the average of the four SGPA obtained by a student in four semesters during the concerned academic session of the M.Sc. course of two years.
i.e. CGPA = Σ (SGPA1 + SGPA2 + SGPA3 + SGPA 4) / 4

N.B. 1 If a candidate obtains ***"F" letter grade*** in a particular paper, he/she would be deemed to have failed in that paper only. If the said candidate desires to continue the course he/she would be required to repeat that course in a supplementary examination in the next coming semester when offered. The candidate would have a maximum of two chances (excluding the first) to appear and qualify the examination in the said papers(s) in next two consecutive years. A candidate who still fails to pass the examination or remain absent in the examinations of the said papers(s) would be dropped from the rolls of the College.

N.B 2 A candidates might remain ***"absent"*** in not more than two papers in a semester. Such a candidate who has remained absent in one/two paper(s) may be allowed to continue in the following semesters, provided the candidate secures at least 40% marks in each of the rest of the papers in the last semester. However, the candidate would have to appear for the examination and qualify in the same paper(s) in the following year. Otherwise that candidate would have to repeat the entire semester in the next year. However, such a candidate would have a maximum of two chances (excluding the first) to qualify a semester in next two consecutive years. A candidate who still fails to qualify the semester or remain absent in the examinations of the said papers(s) would be dropped from the rolls of the College.

N.B 3 There would be no provision for supplementary examination in the same year for a given semester and a candidate who was absent in one/two paper(s) would have to wait for one academic year for clearing the same 'absent' paper(s) of the said semester.

Semester 1

MCBT101: Biomolecules & Enzymology

Course objectives:
The objective of this course is to gain an insight into the Structure and Functions of Carbohydrates, Proteins, Lipids, Nucleic acids and a detailed discussion into the fundamentals of enzyme structure and function and kinetics of soluble and immobilized enzymes. Also it deals with current applications and future potential of enzymes.

Course outcomes:
The student will be able to conceptualise the Structure and function of different simple and complex Carbohydrates with their stereochemistry; primary, secondary, tertiary and quaternary structure and functions of different proteins and their folding patterns; basic and advanced concept of lipid and nucleic acids, structure, functions and the mechanisms of action of enzymes. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.

Carbohydrates:

Bonding & Interactions: Structure of atoms, molecules and chemical bonds, stabilizing interactions: Vander Waals, electrostatic, Hydrogen bonding, hydrophobic interactions etc., Families of monosaccharides. Stereoisomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose. Disaccharides; concept of reducing and non-reducing sugars, Reaction of carbohydrates, Anomeric effect (Methylation effect) Haworth projections of maltose, lactose, and sucrose, Polysaccharides: storage polysaccharides (starch and glycogen). Structural Polysaccharides (cellulose and chitin), structure and role of proteoglycans, Glycoproteins, glycolipids (gangliosides and lipopolysaccharides), protein glycosylation & its significance.

Stereochemistry:
General concepts on: Plane of symmetry, centre of symmetry, Concepts of chirality, optical isomerism; DL, RS nomenclature; Projection formula (Fischer & Howarth); Isomeric anomers;
Stereochemistry of cyclohexane; idea of axial and equatorial bonds (related to chair form conformation), Important chemical reactions relating to configurations, Mutarotation and its mechanism.

Amino Acids and Proteins:

Chemical properties of water: ionic product of water, pH: definition, effect of pH on enzyme, Acids, bases and buffers in biological system, Aminoacids: structure, function and classification, Physico-chemical properties of amino acids, Stereochemistry of amino acids, Non standard amino acids, Biologically essential amino acids, Peptides, Ramachandran plot, Structural organization of proteins (primary, secondary, tertiary & quaternary), Covalent and Non-covalent interactions that stabilize the three-dimensional structures of proteins. Forces stabilising protein structure. Structure-function relationship of proteins. Protein folding and chaperones: Protein splicing, unfolding of protein structure, effect of heat, pH and chemicals denaturation and renaturation of proteins, diseases related to protein misfolding

Lipids:

Classification of lipids, Nomenclature and structure of Saturated and Unsaturated Fatty acids, delta and omega-system; Essential fatty acids. Saponification number, Iodine number, Acetyl number of fats. Structure and Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). Storage lipds: triacyl glycerol and waxes, Role in biological membranes. Lipoproteins

Nucleic Acids:

Structure of Nucleotides, Non Watson-crick base pairing and different secondary structure of DNA; DNA – Protein interaction, various protein motifs involved in DNA protein interaction DNA bending and supercoiling and their significance. Denaturation kinetics of DNA and Cot curves.
Structure and properties of different types of RNA, Folding of RNA into higher order structures. Concept of Sn RNA, miRNA.

Purification and separation of nucleic acids,
Concept of chromosome, nucleosome model, Karyotype and Idiogram, different mapping techniques,diploid genome, haploid genome (Neurospora), functional & comparative genomics, fundamentals of human genome, duplication, crossing over and other rearrangements, pesudogene, tandem repeats of different clusters, satellite DNA.

Enzymes:
Nature of enzyme: protein and non-protein, co-factor & prosthetic group, apoenzyme & holoenzyme, IUB classification, active site, cofactors, coenzymes and prosthetic groups, activation energy and transition state, catalytic efficiency, activity, specific activity and turnover no. Principles of Enzyme kinetics: Michaelis-Menten Equation, Significance of K_m and V_{max}, Determination of K_m and V_{max}, Double reciprocal Plot, Eadie- Hofstee plot, two substrate kinetics- single and double displacement reaction (Ping Pong, Bi-Bi reaction), three substrate kinetics, Ligand binding studies, Effect of temperature, pH and Inhibitors (Reversible Inhibition: competitive, un-competitive and non-competitive and Irreversible Inhibition), Allosteric Enzymes and Feedback Inhibition, Isozymes, Abzymes. Regulation of enzymes. Industrial application of several enzymes. Ribozymes

Books: Adams, Voet and Voet, Van Holde, Stryer, Lehninger, Benjamin and Lewin.

MCBT102: Basic Microbiology and Cell Biology

Course Objectives:

Expose students to basic concepts and principles of current microbiology. Explore techniques and tools used to study microbes and microbial diversity. Study of morphology and structures of cellular components. Different approaches of bacterial, fungal and algal classification & their importance. This course is also designed to explore the fundamentals of cell biology. We hope learners will develop a deep intuition to understand the functional logic of a cell. Different advanced molecular approaches of cell division, cell cycle and regulation of cell cycle will be studied. To underscore the importance of cell biology in our lives, we will address questions of cellular disorders, and associated health implications in the human society.

Course outcomes:

Distinguish comparative characteristics of microorganisms and their cultivation techniques. Understand the wide diversity and functions of Gram-positive and negative bacterial cells. Accumulate the knowledge of the major aims and objectives of microbial systematics. Describe processes used by microorganisms for their replication, survival, and interaction with their environment. Explain the theoretical basis of microbiological tools, technologies, and methods, Demonstrate practical skills in the use of microbiological tools, technologies, and methods and apply hypothesis testing to the design and execution of experiments. The case study helps us explore the functional logic of living systems.

Morphology of Prokaryotes: Cell as a basic unit of living systems; precellular evolution of cell; the evolution of cell from prokaryotes to eukaryotes and from single cells to multicellular organisms; Structure of the cell; Bacterial Cell wall: structures, diversities and biosynthesis, different cell wall hydrolyzing enzymes; bacterial endospores: structure, formation and germination; Uncommon bacterial genera: *Rickettsia, Chlamydia, Mycoplasma,* sheathed bacteria, stalked and budding bacteria, gliding bacteria including Myxobacteria. Cellular structure and function; flagella, pili, capsules; specialized features of higher bacteria like budding, gliding bacteria etc.; fruiting body formation in myxobacteria. Internal organization of the cell; General strategies of cell division: bacteria and yeast, molecular genetics of cell cycle regulation; Cell signaling; Two component system, Chemotaxis, Quorum sensing; Regulation of biofilm formation, Cell wall and cell membrane of Eubacteria, other cellular organelles (Flagella and mechanism of chemotaxix, role of FtsZ, MreB, Crescentin, Min C,D,E in maintaining shape and external structure, Arc and Fnr system, Stringent response and bio-film formation), Mechanism of Endospore formation, Glycocalyx and S-layer, Mechanisms of sporulation, chemotaxis and stringent response.

Microbial Systematics:

General account of systematics, Classification and nomenclature; Classification systems-artificial or phonetic, natural and phylogenetic; Species concept; monophyletic, paraphyletic, polyphyletic; Molecular taxonomy, Molecular phylogeny, Molecular chronometers; Polyphasic taxonomy, Numerical taxonomy, Describing a new Prokaryotic species Culture collection.

Archea: Characteristic features and significance of different groups

Cyanobacteria: Characteristic features and significance

Fungi : Outlines of classification of Fungi. Beneficial role of fungi. Fungi as a source of vitamins, growth regulators, organic acids & enzymes, Mycotoxins Ergotism. Symbiotic association of fungi – Mycorrhiza & Lichens.

Eukaryotic Cell wall and Cell Membrane: Plant cell wall; Cell membrane: Membrane structure; Membrane constituents, phospholipids, glycolipids, cholesterol, membrane proteins, receptors and phospholipases, phospholipid bilayer, structure asymmetry, fluid mosaic model of random diffusion of membrane components;

Domains in membrane, natural and artificial membranes, Modern methods to study the cell membrane, , Scanning colorimetry, Chemiluminescence, Freeze-etching, Freeze-fracturing, Hydrophobicity plot, Mechanism of transporters,Medical significance of transporters

Cellular trafficking and protein sorting: Co-translational protein trafficking, Secretary pathway, Concept of signal sequence, SRP, ER Chaperones, ER translocation of polypeptides, N-glycosylation in ER and Golgi complex, Quality control of protein in ER, UER, ERAD, Proteosomal degradation, ER to Golgi transport, Coat proteins, Enterograde and retrograde transport, Vescicle fusion(Factors involved), Lysosomal biogenesis, Endocytocis, Transport in Mitochondria, Peroxisomes and chloroplast; method of studying protein transport

Cytoskeleton and ECM: Microtubules and microfilaments, intermediate filaments, microtubule polymerization dynamics, actin polymerization dynamics, Drug targeting Cytoskeleton, cell crawling, contractile structures, actomyosin complex, muscle contraction, cell adhesion

Cell cycle and its regulation: Overview of cell cycle- mitosis, meiosis, cytokinensis. CDC mutants, cell cycle control of eukaryotes, roles of cyclins, cdks, phosphatases, protein degradation as mechanisms controlling the unidirectional cell cycle, apoptosis, necrosis and programmed cell death and the role of the mitochondria and caspase signalling in these processes.

Cellular signalling: General characteristics, specificity, amplification, desensitization or adaptation and integration; non-receptor mediated cell signalling - gaseous messengers (NO and CO); receptor mediated, cell signalling – ligands (membrane diffusible, eg. steroid hormones and non-diffusible, e.g. peptide hormones and other peptide or protein ligands) and receptors (intracellular, e.g. steroid hormone receptors and cell surface); ion-channel-linked receptors – neurotransmitters; G protein coupled receptors - heterotrimeric G proteins and its effectors (second messengers like cAMP); desensitization process, bacterial toxins as tools in study of receptor signaling; calcium homeostasis calcium signalling.

Books:

- Molecular Biology of the genes by James D. Watson.
- The Cell by Geoffrey M. Cooper.
- Cell and Molecular Biology by Gerald Karp.
- Molecular Cell Biology by Harvey Lodish.
- Molecular Biology of Cells by Bruce Alberts.
- Genes by Benjamin Lewin.
- The world of cells by Wayne and Levis.
- Molecular biology by David Clark
- Madigan M, Martinko J, Bender K, Buckley D, and Stahl D.2015. Brock Biology of Microorganisms
- (14thEd), Pearson education.
- General Microbiology & Immunology by Banerjee & Banerjee

MCBT103: Biophysical Techniques

Course objectives:

To acquaint students with principles, working and applications of Microscopic techniques, spectroscopy Chromatography.

Course outcomes:

Students will be able to gain an understanding of the basic principles of different modern microscopy like Fluorescence, Confocal and Electron Microcopy etc. They will understand the principles and analyse Spectroscopy including, fluorescence, CD, ORD, NMR and ESR, also gaining insights in the applications of chromatography and electrophoresis; modern laboratory techniques like FACS, FRET, FLIP etc., along with modern concept of proteomics such as MALDI/MALDI-TOF etc.

Microscopy:

Numerical Aperture (NA), Resolution, Contrast, magnification, Spherical aberration, Chromatic aberration of optical system. Mathematical expression for limit of resolution in terms of Rayleigh criteria. Empty magnification. Basic principles of oil immersion microscope. Limitations of optical microscopes. Fluorescence Microscopy, Confocal microscopy, Electron microscopy-TEM and SEM, sample preparation for EM, Characteristics and use of lasers, Relation between the applied voltage and wavelength of electrons.

Diffusion, Osmosis & centrifugation:

Diffusion in fluids, Fick's laws (Statement and explanation) Facilitated diffusion e.g. gas exchanges in lungs and regulating principle relating to partial pressure of O_2 and CO_2. Osmosis: Definition, contrast with diffusion, Tonicity and isotonic solutions. Effect of tonicity on R.B.C. Cell nutrition. Centrifugation: principle, types, applications.

Spectrophotometry:

Electromagnetic spectrum, Introduction to concepts of absorption and emission spectroscopy, Absorption of light, Transmittance, Absorbance (Optical density), Lambert-Beer's law and its limitations, Concept of Molar extinction co-efficient, Study of absorption spectra of Proteins and Nucleic Acids, Analysis of Proteins and Nucleic Acids using UV and Visible spectroscopy, Raman spectroscopy, circular dichroism (CD), optical-rotatory dispersion (ORD) and their application in the study of macromolecules, Fluorescence spectra.

Nuclear magnetic resonance; principles behind splitting, spin-spin interaction, spin-lattice interactions, Nuclear Overhauser Effect, nuclear quadruple effects, spectral interpretations; Electron Spin Resonance (ESR), Zero Field Splitting

Chromatography:

Partition co-efficient, paper chromatography and its applications (including 2-D), Thin layer chromatography. Column packing and fraction collection, Gel filtration chromatography, Ion- exchange chromatography and affinity chromatography, GLC, HPLC.

Electrophoresis:

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis and its application in determining molecular size of protein (principle only), difference between native and SDS-PAGE; 2D gel electrophoresis, Agarose gel electrophoresis,

Modern Techniques in biology

FACS, FRET, FLIP, FRAP, Surface plasmon spectroscopy and its application to study biomolecular interaction, Detection and analysis of protein-protein interactions, X-ray crystallography,

Proteomics:

Proteome, nature of proteome, overview of the tools to study proteome, two-dimensional gel electrophoresis (2D-PAGE), Mass Spectrometry (MALDI/MALDI-TOF), Interpretation of Mass Spectra, MS/MS of peptide, Mass spectrometry search engines: Mascot, structural proteomics –protein-protein interactions, Yeast 2-hybrid, Co-immunopurification/Mass-spectrometry, application, Metabolomics (in brief)

Books: Biophysical Chemistry-Cantor and Shimmel, Physical Biochemistry- Van Holde, Physical Biochemistry-David Freifelder, Biochemistry-Voet and Voet, Fundamentals of Light microscopy and Electronic Imaging-Douglas B. Murphy

MCBP101: Biomolecules and Enzymology Practical

Course objectives:
To make students aware of the principles and applications of protein estimation, Thin layer chromatography, quantitative aspects of enzyme assay

Course outcomes:
Working principle of Lowry method and Bradford method of protein estimation. Working principles of separation of amino acids and lipids by Thin Layer chromatography. Enzyme assay including effect of activators and inhibitors on enzyme activity

1. Quantitative Estimation of protein (Lowry Method, Bradford method).
2. Determination of R_f value and separation of amino acids and lipids by Thin Layer Chromatography.
3. Determination of specific activity of alkaline phosphatase.
4. Effect of activator and inhibitor on Enzyme activity (Amylase and alkaline phosphatase).
5. Inhibition of Alkaline phosphatase by EDTA and recovery of enzyme activity by Mg^{+2} ions.
6. Estimation of Ascorbic acid.

MCBP102: Basic Microbiology Practical

Course objectives:
To make students aware of the principles of cultivation and microscopical examination of microbial cell. Cultivation and survival of microbes in different extreme environmental conditions.

Course outcomes:
Preparation of culture media. Cultivation of microbes. Observations of microbes under microscope. Preparation of slides, using different staining methods for microscopic observations. Isolation of microbes from soil, air and water. Microscopical and biochemical identification of microbes.

1. Gram staining of bacteria
2. Fungal staining (Lactophenol-cotton blue method)
3, Determination of BOD and COD
4. Determination of Thermal Death Point (TDP) of bacteria
5. Isolation of UV resistant mutant and determination of lethal effect of UV ray
6. Effect of antibiotics on bacterial biofilm, MIC, MBC
7. Microscopic Examination of *Nostoc, Oscillatoria, Paramoecium, Eugleana, Giardia and Spirogyra*
8. Biochemical identification of microorganisms from water (fresh & polluted), soil and air
9. Isolation of bacteria from rhizosphere & phyllosphere

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MCBAECC: Laboratory Safety Measures & Intellectual Property Rights (IPR)

Course objectives:
To acquire knowledge about basic safety rules in Microbiology Laboratory. To comprehend about criteria in applying and maintaining patents. To be familiarized with the law and enforcement in Intellectual Property Rights. Developing

a superior work ethics and laboratory working condition. Understanding the significance of following and maintaining laboratory safety guidelines

Course Outcomes:
On the completion of the above objectives student will be able to know about IPR and also the importance of protecting their innovation. They will be familiar with international and national law practiced and also recent issues on it. Application of the knowledge of safety measures in laboratories

Safety measures in laboratory:

Concept of sterilization, disinfection, fumigation, control of microbial contamination in laboratories, hand sanitization, culture destruction, routine cleaning of laboratory, safety measures from UV exposure: Laminar Air Flow, Transilluminator, Handling of other instruments: pH meter, autoclave etc, handling of pathogenic culture: biological safety level.

Chemical hazards:

Handling of toxic chemicals: Acids, alkalis, Heavy metal salts, ethidium bromide, phenol, beta-mercapto ethanol, H_2O_2 etc.: Methods of handling in laboratories.

Biological hazards:

Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program

Bioethics:

Biotechnology And Risk Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and bio piracy – ELSI of human genome project. Role of bioethics in research. Prevention and management of plagiarism, fabrication/manipulation of data,

Intellectual property rights:

Introduction to intellectual property and intellectual property rights – types: patents, copy rights, trade marks, design rights, geographical indications – importance of IPR – patentable and non patentable – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO) . Establishment and functions of General Agreement on Trade and Tariff (GATT) and World Trade Organizations. WTO Summits. Rules governing patents. Case studies on patents (Super bug, Basmati rice, Turmeric etc.). Indian Patent Act, 1970 and its amendments. Patent infringements and publication ethics.

BOOKS:

1. Recombinant DNA safety guidelines (January1990), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.

2. Revised guidelines for research in Transgenic plants (August 1998), Department of Biotechnology, Ministry of Science & Technology, Government of India, New Delhi.
3. Patents ,Subbaram N., (2003), , Pharma Book Syndicate, Hyderabad.
4. IPR, Biosafety and Bioethics by Deepa Goel & Shomini Parashar, Pearson Publication, 2013.

Semester 2

MCBT201: Metabolism & Bioenergetics

Course objectives:
To acquaint students with an understanding of the basic metabolic pathways, inborn errors of metabolism and the application of DNA technology to their study, the control and integration of metabolism etc.

Course Outcomes:
By the end of the course the student will be able to: Describe the principles of metabolism and the differences between anabolism and catabolism; Demonstration ability to handle simple mathematical treatments of biological processes; Discuss the role of coenzymes, such as NAD+, FAD and ATP, in metabolism; Outline the metabolic pathways involving glucose, fatty acids and amino acids; Able to show, how the energy released by catabolism is recouped by substrate level and oxidative phosphorylation ; Describe the various types of genetic mutation and inborn errors of metabolism; Describe the methods for detecting and correcting inborn errors of metabolism; Outline the hormonal regulation of metabolism and discuss the role of protein phosphorylation in this context; describe the regulation pathways of metabolism; Working principle of Electron Transport Chain

Bioenergetics:

Extensive and intensive variables; mathematical description of a system with two or more variables, exact and partial differential; first law of thermodynamics, isothermal process, entropy and second law of thermodynamics, reversible and irreversible process, free energy and chemical potential; Gibb's free energy, Concept and Importance of Gibb's free energy in living System, High energy compounds: Basic mechanism of ATP synthesis, substrate level phosphorylation in anaerobic energy metabolism, Energy currency of the cell, Electron Transport Chain (ETC), Idea of Redox Potential, Chemiosmotic Hypothesis and Oxidative Phosphorylation, Inhibitors and Uncouplers.

Carbohydrates Metabolism:

Catabolism and Anabolism, Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis.TCA cycle, glyoxalate pathway, Entner-Doudoroff pathway, phosphoketolase pathway. Microbial Metabolism: Bacterial photosynthesis, energy conservation in chemolithotrophic bacteria, fermentation of carbohydrates, Pasteur effect.

Catabolism of Amino Acids:
Amino acids- Essential, non-essential, glucogenic and ketogenic, Transamination and oxidative deamination, Central role of Glutamic acid, Removal of nitrogen waste from the body, Urea cycle and excretion of Nitrogen.

Catabolism of Fatty Acids:
Transport of fatty acids into Mitochondria, β-oxidation of saturated odd and even chain fatty acids (Reactions and Energetics), Ketogenesis, Biosynthesis of fatty acids and cholesterol (outline).

Nucleotide Metabolism:
Biosynthesis of purine & pyrimidine (de novo & salvage pathways); degradation of purine & pyrimidine.
Books: Voet and Voet, L. Stryer, H.W Dolle, Nelson & Cox.

MCBT202: Fundamentals of Molecular Biology

Course objectives:

The course aims to equip students with a basic knowledge of the structural and functional aspects of biological macromolecules, viz., DNA, RNA and proteins. The students are able to learn the basic mechanisms replications of biological molecules and also their regulations. Chromosomal remodelling and regulation of gene expression by modification of DNAs are also covered in these topics.

Course Outcomes:
After completion of the course, the students can apply this knowledge in their fields of research and higher education. The topics like **Regulation of Prokaryotic and Eukaryotic Genes,** Concept of quality control of gene expression and coupling of different steps of gene expression are the fundamentals of Genomics and system biology. These are the basics of future research. This course has also practical and commercial applications.

DNA Replication in Prokaryotic and Eukaryotic Cells:

Detail enzymology with structure and mechanism of action of each enzyme. Determining the speed of DNA replication. Detailed mechanisms of initiation, elongation and termination, experiments underlying each steps and role of individual factors, regulation and control of replication. Concept of bidirectional replication. Relation with cell cycle Problem of linear DNA replication,Telomere and Telomerases. Plasmid replication and regulation of copy number.

Flow of Genetic Information and Mechanism of Transcription:

Prokaryotic Transcription - Detail structure and mechanism of action of RNA polymerase II. Promoters, Sigma Factors, Sigma switching. Initiation, Elongation, Rho-dependent and independent terminations, Concept of anti-termination.

Eukaryotic Transcription: Detail structure and mechanism of action of RNA polymerase I,II and III. Different classes of eukaryotic Promoter, Enhancers: General Transcription factors, Activators, mediators. Transcription Termination.

RNA Processing:

Capping and Polyadenylation, mRNA splicing, *cis*- and *trans* splicing, Chemistry of Splicing, Spliceosome and SR proteins, Alternative Splicing and Exon Shuffling, Splicing of Group I and II introns, Tetrahymena self splicing introns, Ribozyme, mRNA editing, folding, export.

Protein Synthesis and Translation:

Ribosome structure and function, Genetic code, tRNA and Wobble hypothesis, Fidelity and control of translation, mRNA degradation,.

Protein Folding:

Protein Folding:Protein folding dynamics, Leventhal Paradox, Concept of molten globule, Landscape theory, Folding funnel model, Role of molecular chaperons, Ubiquitination and protein degradation.

Regulation of Prokaryotic and Eukaryotic Genes:

Concept of regulation at different layers, negative vs. positive regulations; regulations in prokaryotes, concepts of operons and regulatory molecules, eg. inducers, repressors etc., model operons eg. lac and trp operons, lytic/lysogenic switches in bacteriophage lambda, Positive regulation in eukaryotic cells at transcriptional and post-transcriptional levels, basic and accessory transcription factors, enhancers and alternative splicing and polyadenylation; NPCs and another control point of gene regulation, regulation of gene expression after export eg. at the levels of mRNA localization, translation and decay, Regulation of gene expression by micro RNAs,Histone modification and other eukaryotic regulation processes.

RNA Interference:

Doing reverse genetics with RNAi. Concept of quality control of gene expression and coupling of different steps of gene expression.

Epigenetics:

Chromosomal remodelling and regulation of gene expression by modification of DNAs, Fundamentals of Genomics and system biology with very basic concepts of genome analysis

Books:

1. "Molecular Biology" by Friefelder David.
2. "Gene VIII" by Lewin Benjamin.
3. "Molecular Biology of the Gene" by Watson J D.
4. "Molecular Biology" by Weaver R F.

MCBT203: Recombinant DNA Technology

Course Objectives:
This course will cover isolation and purification of nucleic acids, mechanisms of gene cloning, practical aspects of recombinant DNA technology, model organisms in recombinant DNA technology, recombinant gene expression systems.

Course Outcomes:
At the end of the course, the students should be able to: Isolate and purify nucleic acids for routine laboratory procedures, Explain the underlying mechanisms of gene cloning, Discuss the practical aspects of applying recombinant DNA technology, Explain the significance of model organisms in recombinant DNA technology, Describe recombinant gene expression systems, This course has a commercial applications and students can get opportunities in different R & D industries

Enzymes used in RDT:

Restriction enzymes, terminal transferase, polynucleotide kinase, different types of ligases, S1 nuclease etc., Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries. Blue-white screening method,in vitro mutagenesis.

Vectors: plasmid, Ti plasmids, phage, cosmid, M 13, BAC, HAC and YAC vectors; in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level.

Techniques used in RDT:

Micro array based techniques; RFLP, RAPD and AFLP techniques, Crisper-Cas technique ; PCR- Types, uses, drawbacks & advantages, Hybridization technique: Southern, Northern, Western, South-Western & Far Western blotting

Application of RDT: Industrial production of insulin, Application of PCR in Medical Sciences; Concept of gene therapy: different methods, advantages & limitations, Transgenic plants: BTcotton. Recombinant Vaccine, Molecular Diagnosis of Genetic Disease (RFLPs, SNP genotyping, genotyping by sequencing); PCR in microbial diagnosis; Sequencing in microbiology; DNA Fingerprinting & Forensics.

Books: 1. Principles of Gene Manipulation and Genomics by Twyman and Primrose

2. Gene Cloning and DNA Analysis by T.A Brown

Paper: MCBP201: Molecular Biology and Recombinant DNA Technology Practical

Course Objectives:
This course will cover isolation and purification of genomic DNA, Practical aspects of recombinant DNA technology, Applications of Molecular Biological techniques in different scientific fields.

Course Outcomes:
At the end of the course, the students should be able to: Protein isolation & purification from living samples. Isolate and purify genomic DNA for routine laboratory procedures, Able to handle different sophisticated instruments and techniques used in recombinant DNA technology, Handling of PCR Instrument and its practical applications, This course has a commercial applications and students can get opportunities in different R & D industries

1. Column chromatography
2. Genomic DNA isolation from blood and purity check of DNA,
3. Restriction digestion of DNA,
4. Ligation of digested samples,
5. PCR
6. RAPD/RFLP,
7. GFP cloning/Blue-white screening
8. Colony PCR

Paper: MCBP202: Environmental Microbiology Practical

Course Objectives:
This course will cover Isolation of free living N_2 fixers, heavy metal resistant bacteria from soil or water, Isolation of antimicrobial substance producing bacteria from soil, Isolation of pollutant degrading bacteria from soil, Evaluation of PGPR characteristics of rhizobacteria etc.

Course Outcomes:
At the end of the course, the students should be able to isolate Nitrogen fixers, heavy metal resistant etc and analyse their ecological significance and biochemical mechanisms behind their biodegradation ability and soil microbial processes.

1. Isolation of free living N_2 fixers from soil
2. Isolation of heavy metal resistant bacteria from soil or water
3. Isolation of antimicrobial substance producing bacteria from soil
4. Isolation of pollutant degrading bacteria from soil
5. Evaluation of PGPR characteristics of rhizobacteria

MCBSEC: Environmental Microbiology

Course Objective:

To gain insight into the concept of air, soil, and water microbiology, To understand the Bioremediation of Environmental pollutants using microbes, To elaborate on different types of waste management.

Course Outcome:
The course content would make a student enriched with basic knowledge regarding the roles of biodiversity and ecosystem services in sustaining humans and other lives on earth and information on how both are threatened by irresponsible human activities. The students will be benefited by developing knowledge on : Details of air, soil, and water microbiology, Biodegradation of environmental pollutants, bioventing, bioaugmentation, biosensors, bioleaching, use of microbes to detoxify heavy metals and in oil and mineral recovery, Biomass waste management of plant's residues biotechnological applications of enzymes in various productions, liquid waste management as well as solid waste management, Upon completion of the course the students will understand the major concepts of environmental science, Identify how toxic chemicals used for many purposes are affecting ecosystem and human health and apply the scientific method and quantitative techniques to describe, monitor and understand environmental systems

Aeromicrobiology: Microbes of indoor and outdoor environment, Bioaerosols, Enumeration (Different air sampling methods), Extramural and intramural, Control of air microbes, bioterrorism.

Soil Microbiology : Soil as microbial habitat. Soil profile and properties, soil formations, Diversity and distribution of microorganisms in soil.

Water Microbiology: Microbes in marine and fresh water environment – Eutrophication, Indicator organism, Microbiology of Domestic water, Microbial water Quality– Municipal water purifications, Test for potability of water and its significance.

Bioremediation of Environmental Pollutants: Biodegradation of TNT, PCB, Petroleum, Hydrocarbons and Pesticides Bioremediation: bioventing, biofiltration, bioaugmentation, problems and advantages, Microbial strategy to detoxify heavy metals, use of microbes as biosensors. Microbes in oil and mineral recovery. Bioleaching of Copper gold and uranium,

Waste Management: Biomass waste management of plant's residues: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofules, (v) animal feed production.

Liquid waste management: Treatment of sewage (Primary, Secondary andTertiary treatments), Treatment of Industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters)

Solid waste management: Solid waste types, composting, landfill development, incineration methods, composting , electronic waste management. Microbial fuel cell

Semester 3

MCBT301: Microbial Genetics

Course Objective:
Know the terms and terminologies related to microbial genetics and understand the properties, structure and function of genes in living organisms at the molecular level, Explain the concept of recombination, linkage mapping and elucidate the gene transfer mechanisms in prokaryotes and eukaryotes.

Course Outcome:
After completing the Microbial Genetics course, students will be able to: Handle and independently work on lab protocols involving molecular and genetic techniques, Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, read graphs, and understand and use information from scientific papers, Demonstrate skill in communication of scientific data in standard format.

Bacterial & Viral Genetics:

Transformation, Conjugation and transduction, Mutation and its different types, Bacteriophage Genetics - Plaque Formation and Phage Mutants; Genetic Recombination in Virulent Bacteriophages; Fine Structure of the rII Gene in Bacteriophage T4, Genetic Recombination in Temperate Bacteriophages – Lysogeny; Generalized and Specialized Transducing Phages and the mechanism of gene transduction,Transposable Elements - Transposons in Genetic Analysis

Recombination at the Molecular Level:

Homologous recombination, Rec A and RecBCD system, Chi-Sequence, Holliday junction and Ruv System, Site specific Recombination.

DNA Damage and Repair:

Replication Errors, mutations and other kinds of damages, Physical and chemical mutagen, Enzymology, Genetics and mechanisms of DNA Repair, Photoreactivation, Base and Nucleotide excision repair system, Mismatch Repair System, SOS Repair System. chromosomal aberration and related diseses

Genetics of Yeast : Yeast as model, Budding and fission, mating types and its determination (only elementary idea) mating type Mitosis and Meiosis, cell cycle switching,cdc mutants, Anti fungal drug, nistatin

Chromosomal mutation: Deletion, duplication, inversion, translocation

Chromosomal aberration: Cause of chromosomal aberration. Aneuploidy, Polyploidy, Nullisomy, Trisomy, Mendelian genetics: Mendel's Law, deviation, rediscovery, chromosomal theory of inheritance, concept of allele, pseudoallele, Extension of Mendelian genetics

Population genetics: Pedigree analysis, lod score for linkage testing, QTL mapping

MCBT302: Virology

Course Objectives:
The aim is to promote the knowledge and expertise in microbiology with a particular focus on virology and cancer. Students will develop an understanding of the scientific basis of established and novel cancer and virology concepts, as well as the specialist knowledge, practical skills and critical awareness required to enable students to pursue a career in virology and cancer. The specific aims/objectives are to: Provide knowledge in cancer and virology; Develop understanding of processes at the molecular level; Provide a training in laboratory and research skills;

Course outcomes:
Knowledge and Understanding fundamentals of molecular cancer and viral biology; the structure of viruses and their genomes; virus gene expression, modes of replication and transmission, the interaction of viruses with cells and pathogenesis of virus-induced diseases, the detection, treatment and prevention of virus infections; virus epidemiology and the genetics and evolution of viruses, Intellectual Skills and other Attributes understand the nature of viruses and their role in disease pathogenesis; integrate and evaluate information and data from a variety of sources; Knowledge on cancer tumorogenesis, oncogenes, protooncogenes, metastasis, tumor suppressor genes, and the factors causing cancer.

Structure and morphology of viruses: Lytic and lysogenic cycles of bacteriophage λ - marvels of transcriptional control; spite-specific recombination in lambda (generalized and specialized transduction); problems in replication of the ends of linear DNA and how viruses circumvent the problem with examples of T-4 (terminal redundancy and circular permutation), λ (rolling circle model of replication, concatemers, site-specific cleavage), adenovirus and retrovirus (AIDS); SARS CoV2, Monkey pox- genetic make up, evolution, vaccination strategy

Viruses as vectors for recombinant DNA technology: M13, fd, TMV, Ti, Baculovirus, Adenovirus, Retrovirus; oncogenic viruses; oncolysis - VSV.

Cancer & Antiviral Therapy: Incidence and etiology of cancer, genetics of cancer, hallmarks of cancer, metastasis, molecular and cellular events, such as regulation of gene expression, genome maintenance, cell growth and death, differentiation, cell-cell recognition, signaling, and homeostasis, Antiviral drugs & their mechanism.

MCBT303: Immunology

Course objectives:

Demonstration and understanding of key concepts in immunology, Understand the overall organization of the immune system, Understand pharmacological basis of immunology etc.

Course outcome:
After completing the Immunology course, students will be able to: Understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies, Learn about immunization and their preparation and its importance, Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, read and understand the information from scientific papers, Demonstrate skill in communication of scientific data in standard format**,** Expose students to cytokine Receptors, Cytokine Antagonists, Cytokine secretion by Th1 and Th2 subsets, Cytokine related diseases, Therapeutic uses of cytokines, cytokine storm, Understand immunological tolerance, Autoimmunity-Mechanism of different autoimmune diseases in human, hypersensitivity, To make aware of the students for various immunological Techniques including immunofluorescence, Immunohistochemistry, immunoprecipitation, DNA fiber assay, BrdU labelling.

Immunoglobulins:

Structure and function, Immunoglobin genes, generation of diversity, affinity maturation, Isotype switching, Allelic exclusion, lg receptor of B-cells, B-cell maturation, activation and differentiation, Monoclonal and polyclonal antibody, antibody engineering.

Major histocompatibility complex:

MHC antigens, allograft rejection, inbred and congenic mice, MHC locus in mice and human, MHC antigen structures and genes, HLA typing and disease association. Antigen processing and presentation.

T cell activation:

T-cell receptor complex and genes, T dependent and independent antigen.TCR gene rearrangement, T-cell differentiation, thymic selection, super antigens, T-cell cytotoxicity.

Properties of Cytokines: Cytokine Receptors; Cytokine Antagonists; Cytokine Secretion by T_h1 and T_h2 Subsets; Cytokine-Related Diseases; Therapeutic Uses of Cytokines, Toll like receptor,CRP, Cytokine Storm

Immunological tolerance: Autoimmunity – Mechanism of different autoimmune diseases in human, Hypersensitivity – Type I, II, III, IV hypersensitivity & their mechanism

Immunological Techniques: ELISA, ELISPOT assay, Hybridoma technique, Agglutination reactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition, Radio immunoassay, Immunofluorescence, Immuno-histochemistry, immunoprecipitation, DNA fiber assay, BrdU labelling.

MCBDSE01: Bioprocess Technology (Theory)

Course Objective:
Get equipped with a theoretical and practical understanding of industrial microbiology, Appreciate how microbiology is applied in manufacture of industrial products, Know how to source for microorganisms of industrial importance from the environment.

Course Outcomes:
After completing the Applied Industrial Microbiology course, students will be able to: Apply various methods for their isolation, detection and identification of microorganisms in industries, Practice the theories and principles of industrial microbiology in practical, real-world situations and problems.

An Overview of Fermentation Technology:

General requirement of fermentation process, basic configuration of fermentor primary and secondary metabolites, Industrial microorganisms: isolation, preservation, screening and strain improvement and maintenance. Formulation of industrial media: Medium requirements for fermentation processes, carbon, nitrogen, mineral sources, buffers, antifoam agents, medium optimization. Stoichiometry of cell growth and product formation, Mathematical expressions of Batch culture and Continuous culture, Sterilization of media and fementers, scale – up process and starter culture technology

Basic Design of Fermentor

Types of fermentation vessels. Aseptic operation, containment, Body construction (stirrer glands, bearing, valves, steam traps) baffles, spargers and impellors. Types of fermentations: batch, continuous, fed-batch, solid state, sub-merged. Aerobic and anaerobic, dual and multiple fermentations, their advantages and disadvantages.

Aeration and Agitation:

Fick's law, theories of mass transfer, mass transfer between two phases, role of aeration and agitation in a bioprocess, oxygen transfer methodology in a fermentation process, significance of volumetric transfer coefficient (KLa) and its determination, factors affecting KLa values in a bioreactor, power requirements in gassed and ungassed bioreactors, rheological characteristics of fermentation fluid

Significance of Downstream Processing In Industrial Fermentation Processes

Problems and requirements of bio product purification and recovery. Physico- chemical basis of bio separation processes. Fermentation economics - Market potential, some effects of maintenance legislation on production of antibiotics and recombinant proteins, plant and equipment

Brief outline for the production of the following commercially important products

A. Primary metabolites i. Organic acids: Citric acid, lactic acid, ii. Amino acids: Glutamic acid, L – lysine, iii. Solvents: Acetone, ethyl alcohol

B. Secondary metabolites i. Antibiotics: Streptomycin, penicillin ii. Vitamins: B12, Riboflavin, iii. Biofuels : Hydrogen, methane.

MCBDSE02: Industrial & Food Microbiology (Theory)

Course Objective:
Get equipped with a theoretical and practical understanding of industrial microbiology, Appreciate how microbiology is applied in manufacture of industrial products, Know how to source for microorganisms of industrial importance from the environment, Impart the basics of probiotics from different food products and their role in health benefits, Illustrate the biochemical and physiological mechanisms of probiotics, Explain the formulation and marketing of probiotics as nutritional supplements

Course Outcomes:
After completing the Applied Industrial Microbiology course, students will be able to: Apply various methods for their isolation, detection and identification of microorganisms in industries, Practice the theories and principles of industrial microbiology in practical, real-world situations and problems, Describe the fundamentals of probiotic technology and the possibility of its commercialization, Categorize the different sources of probiotics along with their uses, Assess the various beneficial bacteria and their interaction with food, Interpret the biochemical and molecular mechanisms of probiotics, Explore the various applications of probiotics in disease prevention and management, They will get opportunities to work as scientist in different food and biverages industries, Pharma industries etc.

Food Microbiology:

Antibiotic fermentations – production of β lactams (penicillins), semi-synthetic penicillins and cephalosporins, amino-glycosides (streptomycin), macrolids (erythromycin), quinines, vinegar (cider, wine vinegar) production

Production of vitamins (B12, riboflavin), enzymes for pharmaceutical industries, vaccines, recombinant proteins (insulin), Microbiology of foods: Vegetables, fruits, milk and non-fermented products, fresh meats, poultry and non-dairy products. Fermented foods (breads, sauerkraut, pickles, tofu), dairy products from microbes (cheese, curd, yoghurt), microbes as food - single cell protein, mushrooms.
Defination – Probiotics, Prebiotics. The general idea of Probiotics (*Lactobacillus, Bifidobacterium, Enterococcus*).
Industrial design of probiotic foods, Production of specific substances (organic acids & Bacteriocins)
Microbial spoilage of foods. Food preservation: Physical, chemical and biological methods

Fermentation:

An overview, isolation, screening and selection of industrially important microorganisms, strain improvement for industrial purposes, use of recombinant DNA technology, cloning vectors, role and applications of genetic engineering in development of industrial strains

Bioreactors:

Design and components of basic fermentor, specialized fermentors for specific purposes – continuous, anaerobic, for gaseous nutrients, for treatment of wastes, trickle flow reactors, cyclone reactors, submerged types, tube reactors, packed bed reactors, lab scale to pilot to industrial – scale up process, online monitoring.

Bioprocessing :

Downstream processing of industrial fermentation processes, product purification and recovery, physico-chemical basis of bio-separation processes, techniques for purification of end products – chromatography, electrophoresis, distillation, crystallization, filtration. Economics of a fermentation process, determination of cost and its recovery, cost cutting strategies, cell and enzyme immobilization, biological waste treatment, hygiene and safety in fermentation industries.

Alcoholic Beverages:

Brief history of development of industrial process, production of beer (brewing) – media (raw materials used), process, maturation, carbonation. Types of beer (lager, pilsner, bock, ale, stout, porter). Whiskeys – types and production, Production of wine – media and raw material used, different types (sparkling wine, burned wine, etc.)

BOOKS:

1. Bailey and oilis, Biochemical engineering fundamentals, McGraw-Hill (2nd Ed),1986
2. Shule and Kargi, Bioprocess Engineering, prentice hall, 1992,
3.Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
4. Microbial Biotechnology: Fundamentals of Applied Microbiology, Glazer AN, Nikaido H. 2013.

MCBP301: Immunology & Virology Practical

Course Objective:
Student are aware of the immunological & Virological techniques and can perform the practical like ELISA, Western Blotting, Rocket Immuno-electrophoresis, Isolation of bacteriophage from water sample, Isolation of viral nucleic acid etc.

Course Outcomes:
After completing the Immunology course, students will be able to: Understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies, Learn about immunization and their preparation and its importance, Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design and get opportunities in various diagnostic, clinical laboratories and Pharmaceutical Industries as technical assistant.

1. ELISA
2. Affinity Chromatography
3. Western Blotting
4. Rocket Immuno-electrophoresis
5. Isolation of bacteriophage from water sample,
6. Isolation of viral nucleic acid.

MCBP302: Industrial & Food Microbiology Practical

Course Objective:
Student will be aware of the techniques used in food & Industrial Microbiology practical. . Isolation of pectinase, chitinase, urease producing microorganisms from natural sources. Brief knowledge about the commercial production of Suerkraut and citric acid

Course Outcomes:
After completing the Industrial & Food Microbiology course, students will be able to: Understand the salient features of isolation of microbes from soil, Learn about the production process 0f citric and Sauerkraut, Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design for industrial production, They may get opportunities in various food processing industries.

1. Isolation of pectinase producing microorganisms from natural sources
2. Isolation of chitinase producing microorganisms from natural sources
3. Estimation of urease isolated from soil bacteria
4. Production of Sauerkraut
5. Production of citric acid

MCBGEC: Basic and Applied Microbiology

Course objective:

To acquire knowledge on the microbial morphology, growth characteristics, sterilization types, different diseases, and microbial culture techniques and applications of microbe in environment

Course outcome:

Students will gain knowledge about The structural aspect of bacteria and their growth pattern, Antisepsis, disinfection, sterilization, chemotherapeutic agents and bacterial drug resistance, Air water and food borne diseases, Different types of microbial culture techniques, Bioremediation, Biofertilizer, Biopesticide, food processing and fundamentals of probiotic technology and other health care products

Unit I

Brief account of bacterial cell structure, Microbial Growth characteristics, growth curve, nucleic acid (structure and function of different forms and types of DNA and RNA),

Unit II

Concept of antisepsis, disinfection, sterilization and chemotherapeutant. General idea on bacterial drug resistance

Unit III

Different air , water, food borne diseases (Cholera, Tuberculosis, Polio, Botulism, Diphtheria, SARS CoV2, Influenza)

Unit IV

Microbial culture techniques- Batch, continuous, fed batch, synchronous culture

Unit V

Application of microbes in environment(Bioremediation), agriculture(Biofertilizer, biopesticide), health care(antibiotic, prebiotic,probiotic), food processing(Fermented food production-curd, cheese, yogurt),

Books :

Environmental Biotechnology. Edited by C. F. Forster and D.A., John Wase. Ellis Horwood Ltd. Publication.

Advances in Waste Water Treatment Technologies. 1998. Volumes II and I by R. K. Trivedy. Global Science Publication.

Biocatalysis and Biodegradation: Microbial transformation of organic compounds. 2000 by Lawrence P. Wacekett, C. Douglas Hershberger. ASM Publications.

Biotechnology in the sustainable environment, Plenum Press, N.Y.

Semester 4

MCBT401: Medical Microbiology

Course Objective:

To acquaint the students with various aspects of basic medical microbiology like Medical Diagnostic Microbiology which includes theory of pathogenesis, infectious diseases, principles of antimicrobials and their applications and modern methods of diagnostic procedures.

Course Outcome:
After completing the Medical Microbiology course, students will be able to: State the recent advances in the field of Medical Microbiology and apply this knowledge in understanding pathogenesis and diagnosis of diseases caused by micro-organisms, Carry out fundamental or applied research involving microbiological work.

Pathogenicity of Microorganism:

Host parasite relationship, Infection process, bacterial pathogenesis. Toxigenicity, Microbial mechanism for escaping host defences.

Antimicrobial Chemotherapy:

Development of chemotherapy, Determining the level of antimicrobial activity, Antimicrobial/ bacterial drugs, Mode of action of antibiotics. Degradation of cell wall, Solubilisation of cell membrane, Replication inhibition, Transcription inhibition, Translation inhibition, Folic acid inhibition, Mode of action of some important antiviral, fungal, protozoan drugs. Mechanism of drug resistance

Human diseases :

Caused by bacteria: *Staphylococcus, Streptococcus, Vibrio, Mycobacterium,* Gastritis *(Helicobacter pylori) , Clostridium, E.coli, Shigella, Salmonella,* prions (Alzheimer's and Parkinson's disease)

Pathogenesis of viral diseases:

Diseases caused by viruses (polio, influenza, pox, HIV and dengue)

Biology of obligate parasites:

Rickettsia, Chlymadia, Trypanosomes, Spirochetes

Protozoa:Malaria, Leishmania, Entamoeba

Fungi: Primary and secondary mycoses, Pathogenesis of fungal diseases

Bioterrorism and Bioweapons : Introduction to Bioterrorism and Bioweapons, Pathogenic microorganisms used for these purpose and their properties, Infectious agents and their epidemiology

MCBDSE03: Developmental & Evolutionary Biology

Course Objective:

This course aims to provide a broad, comprehensive look at the growth and development of complex organisms, embryology with special emphasis on vertebrate models, focusing on both classical experiments and modern molecular and genetic techniques. Origin and evolution of life is also incorporated in this section

Course Outcome:

Developmental biology studies the mechanisms involved in growth and development of complex organisms. In many ways the basic understandings of developmental biology provide an invaluable foundation for other aspects of biology as well as medicine, especially as many health issues can be related back to early developmental defects during embryogenesis. This section of the course is designed to help students in understanding the ecological and effect of xenobiotics on the ecosystem. The students were also aware about the different levels of Biodiversity, threat to biodiversity and consequences of biodiversity loss.

Developmental Biology:

Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Developmental processes: Embryonic development, Morphogen gradient, asymmetric cell division ;Maternal effect genes, Polarity development (dorsoventral and anterior-posterior): Dorsal (ventral), Dpp (dorsal), Bicoid (anterior), Hunchback (anterior), Nanos (posterior);Pattern formation: Notch-Delta (lateral inhibition), Hedgehog, Wnt (5)

Aging and senescence: Mechanism of apoptosis and senescence

Evolutionary Biology:

Origin of life, physical origin of the earth and prebiotic conditions, chemical and cellular evolution, microbial diversification, endosymbiotic origin of eukaryotes. Biodiversity- Different level & aspects, Threat to biodiversity and consequences of biodiversity loss.

MCBDSE04: Advance Biotechnology

Course Objective:

This course aim to provide the updated knowledge like Production of Proteins in Bacteria and Yeast, Microbial Polysaccharides and Polyesters, Metagenomics, Basic of nano-biotechnology, Transgenic technology, Plant and animal cell culture.

Course Outcome:
After completing the course, students will be able to: Learn the recent advances in the field of Microbiology, Biochemistry & Biotechnology and their applications, They can carry out fundamental or applied research involving different microbiological and biotechnological aspects.

Production of Proteins in Bacteria and Yeast:

Biotechnological applications of Microorganisms, Production of SCP, *Spirullina*, Mushroom, Yeast, SCP derived from high energy source

Microbial Polysaccharides and Polyesters:

Xanthan gum, Polyhydroxyalkanoates

Metagenomics:

Cataloging microbes: phylogenetic tree and construction - Construction of a metagenomic library; Analysis of Metagenomic Libraries; Sequence-based Metagenomics Analysis; Function based Metagenomics Analysis; Phylogenetic analysis and Comparative genomics Softwares & Tools, Applications of Metagenomics for Industrial Bioproducts; Escherichia coli host engineering for efficient metagenomic enzyme discovery; Next-generation sequencing approaches to metagenomics; Stable isotope probing: uses in metagenomics; DNA sequencing of uncultured microbes from single cells

Basic of nano-biotechnology:

General concept of nanotechnology, Nanostuctures, Carbon nanotube, nanowares,Nanoclay, Application of nanotechnology in agriculture, food processing, environment and biomedical.

Transgenic technology:

Development of transgenic mouse, transgenic fish, stable transfection

Plant and animal cell culture:

Basic concept of cell culture, Explant culture, Totipotency, Pollen culture, Organ Culture, Leaf culture, Protoplast fusion.

Monitoring cell growth in animal cell culture, factors affecting cell growth, culture media, Identity testing, Stability testing, Advantages and disadvantages, Cell passage, Tripsinization, Sterilization of cell culture room.

MCBP401P: Bioinformatics & Biostatistics (Practical)

Course Objective: To understand fundamentals of Bioinformatics and Biostatistical methods and their application in Microbiology

Course Outcome:

During the courses Students understand how to apply basic statistical methods in laboratory experiments of Microbiology/Biochemistry/Molecular biology, Learn the importance of Standard deviation, standard errors, t-test, ANOVA and other statistical methods in data representation, How to make an experimental data statistically verified and Application of Bioinformatics in strain identification

Theory:

Bioinformatics: Idea of Computational Biology and its need in biological study. Central dogma of bioinformatics. Concept of databases, characteristics and classification of database. Sequences information sources, EMBL , GENBANK, Entrez.

Nucleic acid and protein sequence database and information retrieval; sequence file formats - FASTA & GENBANK. Sequence alignment - pairwise and multiple sequence alignment. Pairwise alignment tool - BLAST and multiple sequence alignment tool-Clustal W. Protein and nucleic acid structure database:Protein information Sources, PDB, SWISSPROT, TREMBL. The Protein Database (PDB); information retrieval from structural database, Dendogram, Cladogram, Evolutionary relationship. Sequence annotation, sequence alignment, Tree building packages MEGAX, Protein viewing softwares RasMol/PyMol, DNA barcoding, Computer aided drug designing

Introduction to Biostatistics

Keywords and terms used in biostatistics. Concept of frequency distribution (frequency distribution table, simple and group frequency distribution, data presentation), mean, median, mode, standard deviation; Simple problems on mean, median, mode and standard deviation, Statistical error, co-relation & regression, ANOVA

Statistical Distribution

Normal, binomial, poisson's distribution.

Books: Zin Xiong, Mount, Das and Das, Misra: Gun, Gupta & Dasgupta

Practical

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from structural database.
6. Multiple sequence alignment using CLUSTAL X, CLUSTAL W, CLUSTAL omega
7. Phylogenetic tree preparation by using MEGA X
8. Protein structure viewing by using RASMOL
9. Determination of Mean deviation & standard deviation
10. Determination of statistical error and graphical representation with statistical error bar
11. Demonstration of co-relation and regression analysis
12. Determination of t-test and chi square test of biological samples
13. Handling of biological data with ANOVA

MCBP402P: Project Work & Review Work

Students go for a project of 2 months in various Laboratories / Research Institutes to get hands on experience on various techniques and also learn to use various sophisticated instruments used in research. They get a flavor of

research which motivates them to pursue doctoral program. They also join Microbiological R&D industries.

Students have to present a seminar of their project / review work and they have to appear for grand viva examination as well.

Students participate in Journal clubs where they are encouraged to read scientific articles and present their review work. They enlighten themselves on a scientific topic of their interest and its recent advancements which keeps them updated with the ever changing science and technology.

Signature of the Convenor & Members of P.G. BOS, Microbiology Department, Bidhannagar College

1. Dr. Shibani Sen, Convenor
2. Prof. Samir Mukherjee
3. Prof. Subhro K. Mukherjee
4. Prof. Alok Sil
5. Prof. Sanjay Ghosh
6. Dr. Abul Kalam, HOD, P.G. Department of Microbiology