UNIVERSITY OF CALCUTTA

NotificationNo.CSR/13/2023

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 11.07.2023 approved the Syllabi of the under mentioned subjects for semester wise Four-year (Honours & Honours with Research) / Three-year (Multidisciplinary) programme of U.G. courses of studies, as applicable under CCF,2022 . under this University, as laid down in the accompanying pamphlet.

Name of Subject:

1.Anthropology
2.BBA
3.Bengali
4.BFAD
5.Bio Chemistry
6.Botany
7.Chemistry
8.Commerce
9.Economics
10.Education
11.English
12.Geology
13.Hindi
14.History,Islamic History & Culture
15.Home Science
16.Human Rights
17.Journalism & Mass Communication
18.Mathematics
19.Microbiology (Honours)
20.Molecular Biology .
21.Philosophy
22.Physiology
23.Political Science
24.Psychology
25.Social Science
26.Sociology
27.Urdu
28.Women's Studies
29.Zoology

The above shall be effective from the academic session 2023-2024.

12/7/2023

SENATE HOUSE

KOLKATA-700 073

Prof.(Dr.) Debasis Das

Registrar

Semester-wise undergraduate courses in Microbiology (NEP-2020 structure)

Semester	Course Type	Course code	Credit distribution	Course name
I	Core	MCB-CC101*	3 TH + 1 P	Introduction to Microbiology and Microbial Diversity
	IDC/MDC†	Not offered in Semester I		
	SEC	MCB-SEC101	4 TH + 0 P	Food Fermentation Techniques and Packaging
II	Core	MCB-CC102*	3 TH + 1 P	Bacteriology
	IDC/MDC†	MCB-IDC	2 TH + 1TU	Introduction and Scope of Microbiology
	SEC	To be offered centrally by the university		
III	Core	MCB-CC201*	3 TH + 1 P	Biomolecules and Bioenergetics
	Core	MCB-CC202	3 TH + 1 P	Microbial Physiology and Metabolism
	IDC/MDC†	Not offered in Semester III		
	SEC	MCB-SEC201	4 TH + 0 P	Biofertilizers and Biopesticides
IV	Core	MCB-CC203	3 TH + 1 P	Molecular Biology
	Core	MCB-CC204*	3 TH + 1 P	Microbiological Analysis of Air and Water
	Core	MCB-CC205	3 TH + 1 P	Environmental Microbiology
	Core	MCB-CC206	3 TH + 1 P	Food and Dairy Microbiology
V	Core	MCB-CC301	3 TH + 1 P	Virology
	Core	MCB-CC302	3 TH + 1 P	Microbial Genetics
	Core	MCB-CC303	3 TH + 1 P	Industrial Microbiology
	Core	MCB-CC304	3 TH + 1 P	Recombinant DNA Technology
VI	Core	MCB-CC305	3 TH + 1 P	Microbial Biotechnology and Enzymology
	Core	MCB-CC306	3 TH + 1 P	Bacterial Pathogenesis

	Core	MCB-CC307	3 TH + 1 P	Cell Biology
	Internship‖	MCB-INT-TU	0 TH + 3 TU	To be conducted during the semester
VII	Core	MCB-CC401	3 TH + 1 P	Fungal, Protozoal and Viral Pathogenesis
	Core	MCB-CC402	3 TH + 1 P	Instrumentation and Biotechniques
	Core	MCB-CC403	3 TH + 1 TU	Essential Tools in Biological Research
	Core	MCB-CC404	3 TH + 1 P	Immunology
	DSC	MCB-DSC401 (for Non-research students)	3 TH + 1 P	Microbes in Sustainable Agriculture and Development
VIII	Core	MCB-CC405	3 TH + 1 TU	Ecology and Biodiversity
	Core	MCB-CC406	3 TH + 1 P	Genetics and Genomics
	Core	MCB-CC407	3 TH + 1 P	Plant Pathology
	DSC	MCB-DSC402 (for Non-research students)	3 TH + 1 P	Advances in Microbiology
	DSC	MCB-DSC403 (for Non-research students)	3 TH + 1 TU	Medical Biotechnology

***Courses offered as minor also**

†MCB-IDC offered in semester II only

‖Internship to be conducted during the entire duration of semester VI

SEMESTER-I

MCB-CC101: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (FOR BOTH MAJOR AND MINOR)

MCB-CC101-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributionsof Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming

Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microbial World

A. Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

B. General characteristics of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

- **Algae**

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

- **Fungi**

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

- **Protozoa**

General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmaniaand Giardia*

Unit 3 Overview of Scope of Microbiology

Application of microbes in different areas of everyday use and research

SUGGESTED READING

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

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

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

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

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

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

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

MCB-CC101-P (PRACTICAL)

Full Marks : 25 Credit : 1

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation and inoculation of culture media for bacterial cultivation .
4. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
5. Study of *Spirogyra* and *Chlamydomonas, Volvox* using temporary Mounts
6. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba, Paramecium* and *Plasmodium*
7. Determination of size of microbial cell using micrometry.
8. Enumeration of microbes: Yeast by Haemocytometer

MCB-SEC101: FOOD FERMENTATION TECHNIQUES AND PACKAGING

MCB-SEC101-TH (THEORY)

Full Marks : 100 **Credit : 4**

Unit 1 **Fermented Foods**

Definition, types, advantages, and health benefits

Unit 2 **Milk Based Fermented Foods**

Dairy starter cultures, Dahi, Yogurt, Buttermilk (Chach), acidophilus milk, kumiss, kefir, and cheese: Preparation of inoculums, types of microorganisms, and production process

Unit 3 **Grain-Based Fermented Foods**

Idli, Dosa, Bread, Soy sauce, tampeh: Microorganisms and production process

Unit 4 **Vegetable-Based Fermented Foods**

Pickle, Saeurkraut: Microorganisms and production process

Unit 5 **Fermented Meat and Fish**

Types, microorganisms involved, fermentation process

Unit 6 **Probiotics**

Probiotics: Health benefits, types of microorganisms used, probiotic foods available in the market.

Unit 7 **Controlling the Microbiological Quality of Foods**

Quality Control using Microbiological Criteria, Control at Source (Training, Facilities and Operations, Equipment, Cleaning, and Disinfection), Codes of Good Manufacturing Practice (HACCP), Identification of Critical Control Points, Quality Systems: FSSAI, BSI and their importance

Unit 8 **Food Packaging Techniques**

Basic principle of food packaging, importance, techniques in practice, merits and demerits of food packaging techniques

SUGGESTED READING

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.

7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Bibek Ray (2005). Fundamental Food Microbiology (3rd edition), CRC Press

SEMESTER-II

MCB-CC102: BACTERIOLOGY
(FOR BOTH MAJOR AND MINOR)

MCB-CC102-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Cell organization

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae, and pili. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), 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, nucleoids, chromosomes, and plasmids Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological Techniques

Pure culture isolation: Streaking, serial dilution, and plating methods; cultivation, maintenance, and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit 3 Stains and staining techniques

Definition of auxochrome; chromophores; acidic and basic dyes; classification of stains; simple and differential staining: theories of staining, mordant and its function; Gram staining; acid fast staining; endospore staining; negative staining ; capsule staining; flagella staining; mechanism of Gram staining

Unit 4 Microscopy

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 5 Growth and Nutrition

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types, and mode of action

Unit 6 Reproduction in Bacteria

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time, and specific growth rate

Unit 7 Important archaeal and eubacterial groups

Aim and basic principles of classification, systematics, and taxonomy, the concept of species, taxa, strain; Archaebacteria: General characteristics, phylogenetic overview, genera belonging to

Nanoarchaeota(Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)] Eubacteria: Introduction and importance of following groups: Gram Negative: Non-proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples, Delta proteobacteria: General characteristics with suitable examples, Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples
Gram Positive: Low G+ C (Firmicutes): General characteristics with suitable examples
High G+C (Actinobacteria): General characteristics with suitable examples
Cyanobacteria: An Introduction

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
4. PelczarJr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.

MCB-CC102-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Preparation of different media: synthetic media CzapekDox media and /or BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Capsule staining
6. Endospore staining.
7. Isolation of pure cultures of bacteria by the streaking methods.
8. Preservation of bacterial cultures by various techniques.
9. Estimation of CFU count by spread plate method/pour plate method.

MCB-IDC: INTRODUCTION AND SCOPE OF MICROBIOLOGY (OFFERED IN SEMESTER II ONLY)

MCB-IDC-TH (THEORY)

Full Marks : 50 **Credit : 2**

Unit 1 History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis.
Contributionsof Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming
Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microorganisms

Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese'sthree kingdom classification systems and their utility
General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) andCellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya: Algae, Fungi and Protozoa) giving definitions and citing examples
Protozoa : Methods of nutrition, locomotion & reproduction - Amoeba, *Paramecium* and *Plasmodium*

Unit 3 Microscopy

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

Unit 4 Sterilization

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

Unit 5 Microbes in Human Health & Environment

Medical microbiology and immunology: List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types
Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (*e.g.* hydrocarbons in oil spills)

Unit 6 Industrial Microbiology

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

Unit 7 Food and Dairy Microbiology

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

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition,.Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw HillBook Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005) General Microbiology, 5th edition. McMillan.

MCB-IDC-TU (TUTORIAL)

Full Marks : 25 Credit : 1

Students will have to submit a writeup within 3000 words for internal evaluation and viva voce.

SEMESTER-III

MCB-CC201: BIOMOLECULES AND BIOENERGETICS (FOR BOTH MAJOR AND MINOR)

MCB-CC201-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 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: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP

Unit 2 Carbohydrates

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit 3 Lipids

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties, Saponification

Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

Unit 4 Amino acids & Proteins

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D-glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. Biologically important peptides like glutathione, oxytocin-important functions. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary

structures of proteins, Forces holding the polypeptide together, Human haemoglobin structure, Quaternary structures of proteins

Unit 5 Enzymes

General properties, Nomenclature and classification Structure of enzyme: Apoenzyme and cofactors (prosthetic group-TPP, coenzyme NAD, metal cofactors) Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis.

Unit 6 Nucleic Acids

Miescher to Watson and Crick- historic perspective Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Chargaff's rule, Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). Chemical Properties of DNA & RNA: Hydrolysis (acid, alkali), enzymatic hydrolysis

Unit 7 Vitamins

Classification and characteristics with suitable examples, sources and importance

SUGGESTED READING

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

MCB-CC201-P (PRACTICAL)

Full Marks : 25 Credit : 1

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models
7. Study of different types of DNA with the help of models

MCB-CC202: MICROBIAL PHYSIOLOGY AND METABOLISM

MCB-CC202-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph, Peptidoglycan biosynthesis pathway

Unit 2 Nutrient uptake and Transport

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Unit 7 Nitrogen Metabolism - an overview

Introduction to biological nitrogen fixation, nitrogenase-mode of action and regulation, ammonia assimilation, assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

SUGGESTED READING

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education

MCB-CC202-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Study and plot the growth curve of E. coli by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of carbon and nitrogen sources on growth of *E.coli*
5. Effect of salt on growth of *E. coli*
6. Enrichment of phototrophic bacteria from natural sources

MCB-SEC201: BIOFERTILIZERS AND BIOPESTICIDES

MCB-SEC201-TH (THEORY)

Full Marks : 100 **Credit : 4**

Unit 1 **Basics of Biofertilizers**

Understanding the concept of biofertilizers, their types, and their role in enhancing soil fertility and plant nutrition. Various production methods for biofertilizers, including composting, vermicomposting, and the use of microbial cultures. General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Unit 2 **Symbiotic N_2 fixers**

Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants**,** *Frankia*- Isolation, characteristics, Alder, Casuarina plants, non-leguminous crop symbiosis, Azolla - Isolation, characterization, mass multiplication, role in rice cultivation, crop response, field application.

Unit 3 **Non-Symbiotic Nitrogen Fixers**

Free living *Azospirillum, Azotobacter* - isolation, characteristics, inoculum production and field application.

Unit 4 **Phosphate Solubilizers**

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Unit 5 **Mycorrhizal Biofertilizers**

Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhiza and VAM.

Unit 6 **Basics of Biopesticides**

Introduction to biopesticides, their classification, and various sources and modes of action of biopesticides.

Unit 7 **Bioinsecticides derived from microbes**

Types of microbe-based bioinsecticides, their advantages over synthetic pesticides (target specificity, environmental safety, integrated pest management); *Bacillus thuringiensis*: toxin production and field applications, Nucleopolyhedroviruses (NPVs) – application and use

SUGGESTED READING

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH Publishing Co. Pvt. Ltd. NewDelhi.

5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication

SEMESTER-IV
MCB-CC203: MOLECULAR BIOLOGY

MCB-CC203-TH (THEORY)
Full Marks : 75 **Credit : 3**

Unit 1 Genetic Material and its Features

Types of Genetic material: DNA and RNA (mRNA, tRNA, rRNA, miRNA, snRNA etc.). Denaturation and Renaturation of DNA: Hyperchromic effect, Tm, Cot curves. DNA topology and topoisomerase enzyme- linking number, twist number, writhing number. Organization of DNA in Prokaryotes (nucleoid), Eukaryotes (nucleosome-10 nm model, 30 nm model, scaffold arrangement). Organelle DNA - mitochondrial and chloroplast DNA. The Central Dogma.

Unit 2 Replication of prokaryotic DNA

DNA replication - Meselson-Stahl experiment as evidence of semi-conservative replication, Bidirectional and unidirectional replication, Semi- discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication, differences with eukaryotic replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including Θ (theta), rolling circle mode of replication and other accessory proteins, fidelity of DNA replication.

Unit 3 Transcription in Prokaryotes and Eukaryotes

Transcription: Definition, difference from replication, promoter - concept and strength of Promoter, RNA Polymerase and the transcription unit. Mechanism of transcription (initiation, elongation and termination). Transcription in Eukaryotes: major difference with prokaryotic system, important modifications of eukaryotic RNA: concept of introns and exons, RNA splicing, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA and tRNA.

Unit 4 Translation (Prokaryotes and Eukaryotes)

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, genetic code and its features, mechanism of initiation, elongation and termination of translation in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote.

Unit 5 Regulation of gene Expression in Prokaryotes and Eukaryotes

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Yeast mating type switching, changes in chromatin structure: DNA methylation and Histone acetylation mechanisms

SUGGESTED READING

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication

2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco

3. Burton E. Tropp Molecular Biology Genes to Proteins, 3rd Edition, Jones and Bartlett Publishers

4. Robert F. Weaver, Molecular Biology, Fourth Edition, McGraw-Hill International Publishers.

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

6. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.

7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition,

Cold Spring Harbour Laboratory press.

8. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

9. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

MCB-CC203-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Isolation of genomic DNA from *E. coli* and visualization of gDNA in Agarose gel electrophoresis
2. Estimation of salmon sperm / calf thymus DNA using UV spectrophotometer (A_{260} measurement)
3. Estimation of RNA using UV spectrophotometer (A_{260} measurement)

MCB-CC204: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER (FOR BOTH MAJOR AND MINOR)

MCB-CC204-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Aeromicrobiology

Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis

Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures

Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration, sterilization techniques.

Unit 4 Water borne pathogens, water borne diseases

Water borne pathogens: *Shigella, E. coli, Vibrio, Salmonella*, Rotavirus, *Entamoeba*
Water borne diseases: cholera, diarrohea, typhoid, amoebiosis, hepatitis

Unit 5 Microbiological Analysis of Water

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

SUGGESTED READING

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

MCB-CC204-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Assessment of microbiological quality of water

Microbiological examination of water: (Drinking water, Supply water, Pond water)
a) Presumptive test b) Confirmatory test c) Completed test: for coliform ii) IMViC reaction

2. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air

MCB-CC205: ENVIRONMENTAL MICROBIOLOGY

MCB-CC205-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Microorganisms and their Habitats

Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aero microflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiome) & animal (ruminants) body.
Extreme Habitats: Extremophiles-microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

Unit 2 Microbial Interactions

Microbe-microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation
Microbe-Plant interaction: Symbiotic and non-symbiotic interactions
Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 Biogeochemical Cycling

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
Phosphorus cycle: Phosphate immobilization and solubilization
Sulphur cycle: Microbes involved in Sulphur cycle
Other elemental cycles: Iron and manganese

Unit 4 Waste Management

Solid Waste management: Sources and types of solid waste, methods of solid waste disposal (composting and sanitary landfill)
Liquid waste management: Composition and strength of sewage (BOD and COD), primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Unit 5 Microbial Bioremediation

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

SUGGESTED READING

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition, Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition, Pearson/ Benjamin Cummings

3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology, 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology, 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

MCB-CC205-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28^{o}C & 45^{o}C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere.
4. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase, urease) in soil.
5. Report on Field Trip of any nonhazardous, solid waste landfill site (garbage dump, rubbish dump or municipal landfills receiving household waste)/ waste water treatment plant

MCB-CC206: FOOD AND DAIRY MICROBIOLOGY

MCB-CC206-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **Food as a substrate for microorganisms**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 **Microbial spoilage of various foods**

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

Unit 3 **Principles and methods of food preservation**

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit 4 **Fermented dairy products**

Dairy starter cultures, yogurt, dahi, acidophilus milk.

Unit 5 **Prebiotics and Probiotics**

Prebiotics: definition, types, microorganisms, benefits, Fructo-oligosaccharides (FOS) from GRAS organisms (commercial prebiotic).
Probiotics: definition, essential features of a probiotic, types of microorganisms used, health benefits, probiotic foods available in market.

Unit 6 **Food borne diseases (causative agents, foods involved, symptoms and preventive measures)**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;
Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 7 **Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology**

Culture and microscope methods – standard plate count, microscopic counts
Molecular methods: PCR based detection.
Biosensor based methods: optical biosensor, electrochemical biosensor, mass-based biosensor
Immunological based methods: ELISA.

SUGGESTED READING

1. Adams MR and Moss MO. (1995) Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987) Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993) Antimicrobials in Foods. Marcel Dekker, New York.

4. Dillion VM and Board RG. (1996) Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992) Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition, Pearson Education.

MCB-CC206-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. MBRT of milk samples and their standard plate count.
2. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
3. Isolation of spoilage microorganisms from bread.
4. Preparation of Yoghurt/Dahi.

SEMESTER-V

MCB-CC301: VIROLOGY

MCB-CC301-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Nature and Properties of Viruses

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin

Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses

Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit 2 Bacteriophages

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage, genetic basis of lytic vs lysogenic switch of lambda phage

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal

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

Unit 4 Viruses and Cancer

Introduction to oncogenic viruses, types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication

MCB-CC301-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph
4. Isolation of bacteriophages from water/sewage sample using double agar layer technique
5. Phage Titration
6. Isolation of Nucleic Acid from Phage

MCB-CC302: MICROBIAL GENETICS

MCB-CC302-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Nucleic acid as genetic material

Experimental evidence for DNA and RNA as genetic material: experiments of Griffith, Avery MacLeod and McCarthy, Hershey and Chase, Fraenkel and Conrat.

Unit 2 Mechanisms of Genetic Exchange

Transformation - Discovery, mechanism of natural competence

Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping

Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit 3 Mutations, Repair and Recombination

Mutations and mutagenesis: Definition and types of Mutations (tautomeric shift, base analog, alkylating agent, UV radiation and thymine dimers, replicational error). Mutagenic agents: Physical and chemical mutagens Molecular basis of mutations, Functional mutants (loss and gain of function mutants), Uses of mutations.

Repair of DNA: Mismatch and nucleotide excision repair, photoreactivation, SOS repair, error prone repair

Reversion and suppression: True revertant; Intra- and inter-genic suppression; Ames test; Mutator genes

Recombination: Homologous recombination (Holiday structure-RecBCD system).

Unit 4 Plasmids

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids. Yeast plasmids- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, Regulation of plasmid copy number, curing of plasmids

Unit 5 Transposable elements

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon

Eukaryotic transposable elements - Maize (Ac/Ds), LTR and Non-LTR transposons, LINES and SINES. Uses of transposons and transposition

SUGGESTED READING

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings

2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning

4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
6. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
7. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
8. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
9. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd Ed., Jones and Barlett Publishers

MCB-CC302-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Effect of UV on bacteria and plotting of survival curve
2. Demonstration of Master and Replica plate preparation
3. Isolation of Plasmid DNA from *E. coli* and study of different conformations of plasmid DNA through Agarose gel electrophoresis
4. Bacterial Conjugation

MCB-CC303: INDUSTRIAL MICROBIOLOGY

MCB-CC303-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Introduction to Industrial microbiology

Brief history and developments in industrial microbiology

Unit 2 Isolation of Industrial Strains and Fermentation

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit 4 Down-stream processing

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase), wine, beer

Unit 6 Enzyme immobilization

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)

SUGGESTED READING

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

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

MCB-CC303-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation of Enzymes: Amylase (Both qualitative and quantitative only) and Protease (Qualitative only)
3. Whole cell immobilization and detection through any one enzyme assay (Qualitative only)
3. A visit to any educational institute/industry to see the operation of instruments and other downstream processing operations.

MCB-CC304: RECOMBINANT DNA TECHNOLOGY

MCB-CC304-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Molecular Cloning: Tools and Strategies

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties

Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs, Use of linkers and adaptors

Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 2 Methods in Molecular Cloning

Transformation of DNA: Chemical method, Electroporation

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery

DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit 3 DNA Amplification and DNA sequencing

PCR: Basics of PCR, Types of PCR: Nested PCR Inverse PCR, Multiplex PCR, RT-PCR, Error-prone PCR, Real-Time PCR,

Sanger's method of DNA Sequencing: traditional and automated sequencing, Primer walking and shotgun sequencing

Unit 4 Construction and Screening of Genomic and cDNA libraries

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

Unit 5 Applications of Recombinant DNA Technology

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, DNA fingerprinting- RAPD, VNTR Typing, site directed mutagenesis, phage Display

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition.

Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

MCB-CC304-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Bacterial Transformation and calculation of transformation efficiency
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3. Interpretation of sequencing gel electropherograms
4. Designing of primers for DNA amplification
5. Amplification of DNA by PCR

SEMESTER-VI

MCB-CC305: MICROBIAL BIOTECHNOLOGY AND ENZYMOLOGY
MCB-CC305-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Microbial Biotechnology and its Applications

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technologyUse of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology

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

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

Unit 3 Applications of Microbes in Biotransformations

Microbial based transformation of steroids and sterols; Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute

Unit 5 Microbes for Bio-energy and Environment

Different generations of biofuel, Bio-ethanol and bio-diesel production:, commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture

Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents

Unit 6 Enzyme Kinetics

Enzyme Kinetics - Michaelis-Menten equation; Enzyme Inhibition - Competitive-cite succinate on Malonate dehydrogenase as example, Non-competitive – Cite lodoacetamide on triose phospate dehydrogenase and EDTA as example; Suicide inactivation-action of penicillin on bacterial cell wall biosynthesis as an example; Regulatory enzymes-Allosteric - Cite CTP on aspartate transcarbamylase as example; Feedback inhibition - Cite Threonine to Isoleucine as example; Ribozyme (catalytic RNA) and Abzyme (use of antibody as enzyme**)** - definition only

SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ

(2014), 9th edition, Mc Graw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology, 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology,4th edition, ASM Press
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition, Elsevier Science
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition, Sinauer Associates, Inc
10. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,
11. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
12. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
13. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company

MCB-CC305-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Estimation of proteins
2. Study of enzyme kinetics – calculation of V_{max} , Km, Kcat values
3. Study effect of temperature, pH, activator and inhibitor on enzyme activity
4. Isolation of an industrially important enzyme producing bacteria

MCB-CC306: BACTERIAL PATHOGENESIS

MCB-CC306-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Introduction to Bacterial Pathogenesis

Basic concepts of infection and host-pathogen interactions, bacterial virulence factors, toxins (types, mechanisms of action, and their effects on the host).

Unit 2 Mechanisms of Bacterial Pathogenesis

Adhesion factors involved in bacterial attachment, invasion strategies, host colonization, inflammatory response of host, tissue damage and disease progression, biofilm formation and quorum sensing

Unit 3 Bacterial Diseases

Following diseases to be studied with reference to the causative agents, symptoms, mode of transmission, pathogenesis, treatment and control

Respiratory disease: tuberculosis (*Mycobacterium tuberculosis*), pneumonia (*Streptococcus pneumoniae)*

Gastrointestinal disease: Salmonellosis (*Salmonella typhi*), cholera (*Vibrio cholerae*)

Sexually transmitted infections: Gonorrhea (*Neisseria gonorrhoeae*), syphilis (*Treponema pallidum*)

Others: Urinary tract infections (*Escherichia coli*), Skin and soft tissue infection (*Staphylococcus aureus*), tetanus (*Clostridium tetani*)

Unit 4 Laboratory Techniques for Culture and Identification of Bacterial Pathogens

Sample collection, transport and culturing of clinical samples. Principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

Unit 5 Antibiotics

Definition, classification of antibiotics based on their mechanism of action, side effects, drug interaction and allergic reactions.

Mechanisms of action of antibiotics: Cell wall inhibitors (beta-lactams), Protein synthesis inhibitors (tetracyclines, macrolides), DNA synthesis inhibitors (quinolones), RNA synthesis inhibitors (rifamycins)

Antibiotic Resistance: Overview of antibiotic resistance mechanisms, factors contributing to the emergence and spread of antibiotic resistance, strategies to combat antibiotic resistance (e.g., stewardship, combination therapy)

SUGGESTED READING

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

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition, McGraw Hill Publication

3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology, 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition, Pearson International Edition.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. SubbaRao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

MCB-CC306-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Identify laboratory strains of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus* (any three) on the basis of cultural, morphological and biochemical characteristics through IMViC test, growth on TSI and nitrate reduction, urease production and catalase tests (any two).
2. Study of composition and use of important differential media for identification of bacteria: EMB agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.

MCB-CC307: CELL BIOLOGY

MCB-CC307-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Structure and organization of Cell

Cell Organization – Prokaryotic and Eukaryotic (Plant and animal cells)
Plasma membrane: Structure and transport of small molecules
Cell Wall: Eukaryotic cell wall, extracellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects)
Mitochondria, chloroplasts and peroxisomes
Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules

Unit 2 Nucleus

Nuclear envelope, nuclear pore complex, nucleoporins and nuclear lamina, nuclear transport
Nucleolus-composition and functions

Unit 3 Protein Sorting and Transport and Targeting

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

Unit 4 Cell Signaling

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

Unit 5 Cell Cycle, Cell Death and Cell Renewal

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

SUGGESTED READING

1. Alberts, B. et al. (2008) Molecular Biology of the cell. 5th edition. Garland Science
2. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
3. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
4. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition, Lipincott Williams and Wilkins, Philadelphia.

5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Watson JD. et al. (2008) Molecular Biology of the Gene. 6th edition, Cold Spring Harbor Laboratory Press

MCB-CC307-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Cytochemical staining of DNA – Feulgen
2. Study of polyploidy in Onion root tip by colchicine treatment
3. Study of different stages of Mitosis
4. Study of different stages of Meiosis

MCB-INT-TU : INTERNSHIP

Full Marks : 75 **Credit : 3**

A literature review is to be conducted during the semester under the supervision of a teacher in the college where the student is enrolled. At the end of the semester, the student will have to submit a review paper and make a powerpoint presentation before a panel of examiners constituted entirely by the internal teachers for evaluation.

SEMESTER-VII

MCB-CC401: FUNGAL, PROTOZOAL AND VIRAL PATHOGENESIS

MCB-CC401-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **Host pathogen interaction**

Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Unit 2 **Viral diseases**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis, Covid.

Unit 3 **Protozoal diseases**

List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar

Unit 4 **Fungal diseases**

Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tineapedis (Athlete's foot) Systemic mycoses: Histoplasmosis, opportunistic mycoses: Candidiasis

Unit 5 **Antimicrobial agents**

General characteristics and mode of action
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.
Anti Protozoal medicine: Chloroquine phosphate, Liposomal amphotericin B, Metronidazole

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology, 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology, 9th edition, McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition, Pearson International Edition

MCB-CC401-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

A dissertation paper will have to be submitted on any viral, fungal and protozoan disease. A viva voce assessment will be conducted on the dissertation paper.

MCB-CC402: INSTRUMENTATION AND BIOTECHNIQUES

MCB-CC402-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Chromatography

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

Unit 2 Electrophoresis

Theory of electrophoresis: Moving boundary and zone electrophoresis, Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophotresis, Gradient Electrophoresis, Immunooelectrophoresis, Instrumentation for Southern and Western Blot.

Unit 3 Spectrophotometry

Interaction of Electromagnetic radiation with matter: scattering and absorption, Principles and applications of absorption spectra, Instrumentation of UV-Vis absorption spectrophotometer, Analysis of biomolecules using UV-Vis spectroscopy, Colorimetry and turbidometry, Introduction to emission spectroscopy: Fluorescence and Phosphorescence and their applications in biology.

Unit 4 Sedimentation

Principles of sedimentation: Boundary and Zone sedimentation; Factors affecting sedimentation velocity and sedimentation co-efficient Preparative and analytical centrifugation, RCF and sedimentation coefficient, determination of molecular weight from sedimentation, differential centrifugation, density gradient centrifugation and ultracentrifugation and their applications, eukaryotic cell fractionation.

Unit 5 Mass Spectrometry

Principles of mass spectrometry, m/z ratio, time of Flight analysis, MALDI and ESI Mass spectrometry, Mass spectrometry as an indispensible tool for Proteomics

SUGGESTED READING

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition, Cambridge University Press, 2010.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM &Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition.

Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition, ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

MCB-CC402-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Separation of amino acids by paper / thin layer chromatography.
2. Separation of proteins by gel filtration chromatography
3. Determination of molecular weight of a protein by SDS-Polyacrylamide Gel Electrophoresis (PAGE).
4. Determination of λ_{max} for an unknown sample and calculation of extinction coefficient.

MCB-CC403: ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH

MCB-CC403-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **Use of statistics in Biological research**

Principles of statistical analysis of biological data. Scope of statistics: utility in biological research. Sampling parameters: Difference between sample and population, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Dependent and independent variables, Curve Fitting, Correlation and Regression. Mean and Variance of Discrete and Continuous Distributions: Binomial, Poisson, and Normal distribution. Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; ANOVA and its applications.

Unit 2 **Fundamentals of Bioinformatics**

Sequence Alignments, Phylogeny and Phylogenetic trees Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood. Types of biological databases: - Genome databases, Protein sequence and structure databases, gene expression databases, Database of metabolic pathways, Indexing databases and Citation databases, retrieval and handling of data from Biological databases.

Unit 3 **Principles of Biosafety**

Biosafety guidelines and regulations (National and International); GMOs LMOs- Concens and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC ete. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit 4 **Introduction to Intellectual Property Rights**

Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR - patentable and non patentables - patenting life - legal protection of biotechnological inventions World Intellectual Property Rights Organization (WIPO)

Unit 5 **Documentation and presentation of biological data**

The art of making presentations for oral and poster sessions in seminars/conferences/scientific meets. The art of scientific writing: numbers, units, abbreviations and nomenclature used in scientific writing. Types of scientific writings: Original Research articles, Short communications, Perspectives, Review/mini-reviews, Introduction to Academic misconduct/ plagiarism, development of practices to avoid plagiarism (including self-plagiarism)

SUGGESTED READING

1. Wilson and Walker's Principles and Techniques of Biochemistry And Molecular Biology Edited by Andreas Hofmann , Samuel Clokie First published 2018
2. Biostatistics & Research Methodology: G Nageswara Rao PharmaMed Press, 2018
3. Research Methodology for Biological science, Gurumani, N, MJP Publishers, 2020
4. Introduction to Biostatistics, Pranab K. Banerjee, S. Chand Publication, 2007
5. IPR, Biosafety And Bioethics 2013 Edition by Goel, Pearson

MCB-CC403-TU (TUTORIAL)

Full Marks : 25 **Credit : 1**

Students will have to submit a project by using bioinformatic tools and statistical approaches on any aspect of biology. The project will be evaluated by the teachers of the college where the student is enrolled.

MCB-CC404: IMMUNOLOGY

MCB-CC404-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Introduction

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of the field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

Unit 2 Immune Cells and Organs

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Unit 3 Antigens

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Unit 4 Antibodies

Structure, Types, Functions and Properties of antibodies; Antigenic Determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Unit 5 Major Histocompatibility Complex

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

Unit 6 Complement System

Components of the Complement system; Activation pathways (Classical, Alternative, and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit 8 Immunological Disorders and Tumor Immunity

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models
(Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit 9 Immunological Techniques

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 5th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland Science Publishers, New York.
5. PeakmanM, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

MCB-CC404-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform immunodiffusion by Ouchterlony method.
4. Perform DOT ELISA.
5. Perform immunoelectrophoresis.

MCB-DSC401: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT

MCB-DSC401-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **Introduction to Agriculture and Sustainable Farming Practices**

An overview of agriculture, its significance in food production, and the need for sustainable farming practices.

Unit 2 **Soil Microbiology**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit 3 **Mineralization of Organic & Inorganic Matter in Soil**

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate,nitrate, silica, potassium

Unit 4 **Microbial Activity in Soil and Green House Gases**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 5 **Secondary Agriculture Biotechnology**

Biotech feed, Silage, Bio manure, biogas, biofuels – advantages and processing parameters

Unit 6 **GM crops**

Benefits, pest and disease resistance, safety, public perception and debate, examples-Bt crops, golden rice, rainbow papaya.

SUGGESTED READING

1. Agrios GN. (2006). Plant Pathology.5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel Decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.

12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

MCB-DSC401-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

Isolation of plant growth promoting rhizobacteria-characterize by nitrogen fixing, siderophore production and phosphate solubilzation potential.

SEMESTER-VIII

MCB-CC405: ECOLOGY AND BIODIVERSITY

MCB-CC405-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **The Environment**

Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves; population regulation.

Unit 2 **Community Ecology**

Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit III **Ecosystem Ecology**

Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); Food Chain, Food web, Trophic level, Ecological pyramids, primary production and decomposition; structure and function of some ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; biogeographical zones of India

Unit IV **Biodiversity**

levels of biodiversity, alpha, beta and gamma diversity, hotspots of biodiversity, Threat to species diversity, Extinction vortex, Causes of extinction; RedData Book, Biodiversity conservation approaches: Local, National and International, In situ and ex situ conservation, Concept of protected area network, Selecting protected areas, criteria for measuring conservation value of areas, Sanctuary, National Park and Biosphere reserves; Design and management of protected areas; Threats to wildlife conservation and wildlife trade; Tools for wildlife research, Wildlife threat, Use of Radiotelemetry and Remote sensing in wildlife research, Indian case studies on conservation/management strategy (Project Tiger).

Unit V Applied Ecology

Environmental pollution; Microorganisms and environmental pollutants, Overall process of biodegradation, Environmental biomonitoring and indicator microorganisms, biodegradation of organic pollutants.

SUGGESTED READING

1. Odum, E.P. (1971). Fundamentals of Ecology. W.B. Sounders Natraj publication (Indian edition).

2. Sharma, P.D.(2017) Ecology and environment, 13th edition, Rastogi Publication.

3. Kormandy E. J. (1996) Concepts of ecology, Prentice Hall of India Pvt. Ltd.

4. Chapman J.L. and Reiss M.J. (2000) Ecology : Principles and applications 2nd edition, Cambridge : University Press.

MCB-CC405-TU (TUTORIAL)

Full Marks : 25 Credit : 1

Student will have to make a field visit to any *ex-situ* conservation site and submit a field report. Evaluation will be based on the viva voce and examination of field report by an external examiner.

MCB-CC406: GENETICS AND GENOMICS

MCB-CC406-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Mendelian Principles

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, incomplete dominance and co-dominance, multiple alleles, epistasis, penetrance and expressivity, epigenetic controls

Unit 2 Linkage and Crossing over

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

Unit 3 Extra-Chromosomal Inheritance

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

Unit 4 Characteristics of Chromosomes

Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome

Unit 5 Genomics

Introduction to genomics; Mapping genomes: Genetic mapping -molecular markers- RFLP, SSLP, SNPs, basis to genetic mapping; Physical mapping- : Restriction mapping and optical mapping, FISH, RH and STS Mapping, Genome sequencing, assembly and annotation; Human genome project; Brief Overview of Structural, functional and comparative genomics; Application of genome data in forensics, disease diagnosis and genetic counselling

SUGGESTED READING

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic

Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings
8. Brown TA (2018) Genomes 4th Ed., Garland Science
9. Primrose SB and Twyman RM (2006) Principles of Gene Manipulation and Genomics, 7th Ed., Blackwell Publishing

MCB-CC406-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Extraction of information of any gene from available genome resources

MCB-CC407: PLANT PATHOLOGY

MCB-CC407-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **Introduction and History of plant pathology**

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates.

Unit 2 **Stages in development of a disease**

Inoculation, prepenetration, penetration, infection, invasion, colonization, dissemination, overwintering/oversummering of pathogens.

Unit 3 **Plant disease epidemiology**

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit 4 **Host Pathogen Interaction**

A. *Microbial Pathogenicity*

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

B. *Genetics of Plant Diseases*

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types ofplant resistance: true resistance– horizontal & vertical, apparent resistance.

C. *Defense Mechanisms in Plants*

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

Unit 5 **Control of Plant Diseases**

Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material

cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches
chemical -protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.
biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants

genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

Unit 6 Specific Plant diseases

Study of some important plant diseases giving emphasis on its etiological agent,symptoms, epidemiology and control

A. Important diseases caused by fungi

Late blight of potato - *Phytophthora infestans* Powdery mildew of wheat - *Erysiphe graminis*
Ergot of rye - *Claviceps purpurea*

Black stem rust of wheat - *Puccinia graminis tritici*
Loose smut of wheat - *Ustilago nuda*
Red rot of sugarcane - *Colletotrichum falcatum*
Early blight of potato - *Alternaria solani*

B. Important diseases caused by phytopathogenic bacteria:
crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas: Aster yellow

D. Important diseases caused by viruses: Rice tungro, Tobacco mosaic

SUGGESTED READING

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of IndiaPvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi

MCB-CC407-P (PRACTICAL)

Full Marks : 25 Credit : 1

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo,Puccinia,Ustilago, Fusarium, Colletotrichum.*

MCB-DSC402: ADVANCES IN MICROBIOLOGY

MCB-DSC402-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 **Systematics, Taxonomy**

Concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers

Unit 2 **Sequencing of nucleic acids and proteins**

Nucleic acid sequencing technologies: Maxam Gilbert sequencing, Sanger's dideoxy sequencing, Pyrosequencing, Next-Generation Sequencing, Protein sequencing technologies: Edman degradation, Sanger's method, Trypsin and Cyanogen Bromide fragmentation, Dansyl and Dabsyl chloride derivatisation

Unit 3 **Evolution of Microbial Genomes**

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

Unit 4 **Metagenomics**

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics

Unit 5 **Molecular Basis of Host-Microbe Interactions**

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, virulence and antimicrobial resistance

SUGGESTED READING

1. Biochemistry, Donald Voet and Judith G. Voet, 4th Edition, John Wiley and Sons, 2011.
2. DNA Sequencing Protocols, 2nd edition, by Graham, Humana Press Inc.2001
3. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
4. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
5. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
6. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
7. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011) Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,
8. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International

MCB-DSC402-P (PRACTICAL)

Full Marks : 25 **Credit : 1**

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16S ribosomal gene primers
4. Reading a DNA sequence from a sequencing gel

MCB-DSC403: MEDICAL BIOTECHNOLOGY

MCB-CC403-TH (THEORY)

Full Marks : 75 **Credit : 3**

Unit 1 Vaccine Development

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Transfusion of immunocompetent cells, Stem cell therapy; Cell based vaccines. Introduction to immunodiagnostics – RIA, ELISA. New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine

Unit 2 Cancer

Regulation of cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches, tumour suppressor genes, modulation of cell cycle in cancer, different forms of cancers. Origin and Terminology, Oncogenes and Cancer Induction, Proto-Oncogenes and Oncogene, Metastasis and Malignant Transformation of Cells Cancer. Growth factors related to transformation. Telomerases. Detection using biochemical assays and tumor markers. Different forms of therapy, chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection. Use of signal targets towards therapy of cancer

Unit 3 Gene therapy

Somatic cell gene therapy and germline therapy, ex vivo and in vivo therapies; vectors used in gene therapy: viral vector: retroviruses, adenoviruses, adeno-associated viruses, lentiviruses; non-viral vector: naked DNA, polymersomes, polyplexes

Unit 4 Cell Culture

Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO2, Serum, supplements, growth factors (EGF, PDGF). Serum and protein free defined media. Culture and maintenance of primary and established cell lines. Biology of cultured cells and culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.

Unit 5 Gene Editing

Introduction to genetics and genetic engineering; RNA interference, limitations of genetic engineering; Genome engineering using Zinc Finger Nuclease (ZFN) Technology; Transcription activator-like effector nuclease (TALEN) Technology; Clustered regularly interspaced short palindromic repeats (CRISPR)/Cas9 technology: target identification, gRNA design, donor design, Applications in treating human diseases: Human cell engineering-Thalassemia, SCID,

Hemophilia, etc; Disease modeling-Cancer, iPSc and animal models; Engineered immune cells for cancer therapy.

SUGGESTED READING

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. 2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings, 2007.
4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC, 2003.
5. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007
6. McDonald, F etal., " Molecular Biology of Cancer" IInd Edition. Taylor & Francis, 2004

MCB-CC403-TU (TUTORIAL)

Full Marks : 25 **Credit : 1**

Evaluation will be done internally on short review and powerpoint presentation.

1. Power point presentations on Safety aspects of cell culture, cell types and culture, knowledge about cell line sourcing, common methods and protocols for cell culture.
2. Visit to a tissue culture laboratory for exposure.
3. Submission of a short review on any cancer related topic to expose the students on how to review journal papers and make a comprehensive summary.

References:

1. Fundamental Techniques in Cell Culture: Laboratory Handbook, 3rd Edition: Sigma Aldrich
2. Cell culture Basics Handbook by Thermo Fisher Scientific.