Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

FIRST SEMESTER

CORE COURSE(4+2 CREDITS)		ABILITY ENHANCEMENT COMPULSORY(2 CREDITS) [Any One]		GENERIC ELECTIVE(4+2 CREDITS) [Any One (T+P)]	
Paper Name	**Paper Code**	**Paper Name**	**Paper Code**	**Paper Name**	**Paper Code**
Biochemistry	CMc-101	Environmental science	AECMc-101	Introduction and scope of Microbiology	GEMc-101
Lab on Biochemistry	CMc-191			Lab on Introduction and scope of Microbiology	GEMc-191
Cell Biology	CMc-102	English communication	AECMc-102	Microbes in Environment	GEMc-102
Lab on Cell Biology	CMc-192			Lab on Microbes in Environment	GEMc-192
		Computer Fundamentals	AECMc-103	Biomathematics and statistics	GEMc-103
				Lab on Biomathematics and statistics	GEMc-193

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

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SECOND SEMESTER

CORE COURSE (4+2 CREDITS)		ABILITY ENHANCEMENT COMPULSORY(2 CREDITS) [Any One]		GENERIC ELECTIVE(4+2 CREDITS) [Any One (T+P)]	
Paper Name	**Paper Code**	**Paper Name**	**Paper Code**	**Paper Name**	**Paper Code**
Introduction to Microbes and Microbial diversity	CMc-201	Environmental Science	AECMc-201	Industrial and food microbiology	GEMc-201
Lab on Introduction to Microbes and Microbial diversity	CMc -291			Lab on Industrial and food microbiology	GEMc-291
Microbial Physiology and Metabolism	CMc -202	Computer Fundamentals	AECMc-202	Chemistry I	GEMc-202
Lab on Microbial Physiology and Metabolism	CMc --292			Lab on Chemistry I	GEMc-292
Food and dairy Microbiology	CMc-203			Inheritance Biology	GEMc-203
Lab on Food and dairy Microbiology	CMc-293			Lab on Inheritance Biology	GEMc-293

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THIRD SEMESTER

CORE COURSE(4+2 CREDITS)		SKILL ENHANCEMENT COURSE(2 Credits) [Any One]		GENERIC ELECTIVE (4+2 credits) [Any One (T+P)]	
Paper Name	**Paper Code**	**Paper Name**	**Paper Code**	**Paper Name**	**Paper Code**
Microbial Genetics	CMc-301	Microbiological analysis of air and water	SECMc- 301	Biomolecular metabolism	GEMc-301
Lab on Microbial Genetics	CMc-391	Bio fertilizers and bio pesticides	SECMc-302	Lab on Biomolecular metabolism	GEMc-391
Molecular Biology	CMc--302	Food and fermentation techniques	SECMc-303	Chemistry II	GEMc-302
Lab on Molecular Biology	CMc-392			Lab on Chemistry II	GEMc-392
Environmental Microbiology	CMc-303			Biodiversity and Taxonomy	GEMc-303
Lab on Environmental Microbiology	CMc-393			Lab on Biological Diversity and Taxonomy	GEMc-393

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Curriculum Structure

(Applicable from the academic session 2018-2019)

FOURTH SEMESTER

CORE COURSE(4+2 credits)		SKILL ENHANCEMENT COURSE (2 credits) [Any One (T+P)]		GENERIC ELECTIVE(4+2 credits) [Any One (T+P)]	
Paper Name	**Paper Code**	**Paper Name**	**Paper Code**	**Paper Name**	**Paper Code**
Immunology	**CMc-401**	**Microbial diagnosis in health clinics**	**SECMc-401**	**Clinical Immunology**	**GEMc-401**
Lab on Immunology	**CMc-491**	**Management of Human Microbial Diseases**	**SECMc -402**	**Lab on Clinical Immunology**	**GEMc-491**
Medical Microbiology	**CMc-402**	**Microbial Quality control in food and pharmaceutical Industries**	**SECMc - 403**	**Entrepreneurship Develpoment**	**GEMc-402**
Lab on Medical Microbiology	**CMc-492**			**Lab on Entrepreneurship Develpoment**	**GEMc-492**

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

FIFTH SEMESTER

CORE COURSE (4+2 credits)		DISCIPLINE SPECIFIC ELECTIVE (4+2credits) [Any One (T+P)from A group and one from B group]	
Paper Name	**Paper Code**	**Paper Name**	**Paper Code**
Recombinant DNA Technology	CMc 501	Advances in microbiology	DSE Mc-501A
		Lab on Advances in microbiology	DSE Mc-591A
Lab on Recombinant DNA Technology	CMc 591	Instrumentation and Bioetechniques	DSE Mc-501B
		Lab on Instrumentation and Bioetechniques	DSE Mc-591B
Industrial Microbiology	CMc 502	Microbial Biotechnology	DSE Mc-502A
Lab on Industrial Microbiology	CMc 592	Lab on Microbial Biotechnology	DSE Mc-592A
		Plant Pathology	DSEMc -502B
		Lab on Plant Pathology	DSEMc -592B

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

SIXTH SEMESTER

CORE COURSE(4+2 Credits)		DISCIPLINE SPECIFIC ELECTIVE(4+2 Credits) [Any One (T+P) from group A and one from Group B]	
Paper Name	**Paper Code**	**Paper Name**	**Paper Code**
Virology	**CMc--601**	**Microbes in sustainable agriculture and Development**	**DSE Mc-601A**
Lab on Virology	**CMc--691**	**Lab on Microbes in sustainable agriculture and Development**	**DSE Mc-691A**
Genomics , Proteomics and Bioinformatics	**CMc-602**	**Biosafety and intellectual properties rights**	**DSE Mc-601B**
Lab on Genomics , Proteomics and Bioinformatics	**CMc-692**	**Lab on Biosafety and intellectual properties rights**	**DSE Mc-691B**
		Project/ Dissertation	**DSEMc-602**

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

SEMESTER I

CMc101-: BIOCHEMISTRY (THEORY)
SEMESTER –I **Full marks 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

UnitI **(14 Periods)**

Carbohydrates:- Structural aspects – Introduction & Occurrence, Classification of Mono-, Di- and Polysaccharides, Reducing & Non-reducing Sugars, Constitution of Glucose & Fructose, Osazone formation, Pyranose & Furanose forms, Determination of ring size, Inter-conversion of monosaccharides.

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

UNIT II **(14 Periods)**

Lipids: Structural aspects – General introduction, Classification & Structure of Simple & Compound lipids, Properties of Lipid aggregates (elementary idea), Biological membrane, membrane protein – structural aspects, Lipoproteins (elementary idea).

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT-III **(8 Periods)**

Chemical & Enzymatic Kinetics - An introduction to enzyme; How enzyme works; Reaction rate; Thermodynamic definitions; Principles of catalytic power and specificity of enzymes; Enzyme kinetics – Approach to mechanism.

UNIT IV **(24 Periods)**

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Lipid Metabolism – Structures and roles of Fatty acids & Glycerols, beta oxidation of saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, Ketone bodies.

Amino acid Metabolism – Amino acid breakdown (amino acid deamination, Urea cycle, metabolic breakdown of individual amino acids – glucogenic & ketogenic amino acids), amino acids as biosynthetic precursors (haem biosynthesis & degradation, biosynthesis of epinephrine, dopamine, seretonin, GABA, histamin, glutathione); biosynthesis of essential & non-essential amino acids.

Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo & salvage pathway); degradation of purine & pyrimidine.

Carbohydrates:- Structural aspects – Introduction & Occurrence, Classification of Mono-, Di- and Polysaccharides, Reducing & Non-reducing Sugars, Constitution of Glucose & Fructose, Osazone formation, Pyranose & Furanose forms, Determination of ring size, Inter-conversion of monosaccharides.

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Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo & salvage pathway); degradation of purine & pyrimidine.

CMc191: BIOCHEMISTRY (PRACTICALS)
SEMESTER –I **Full marks 25**

TOTAL HOURS: 40 **CREDITS: 2**

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
3. Problems on Standard Free Energy Change of coupled reactions
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 effect of temperature, pH and Heavy metals on enzyme activity
8. Estimation of any one vitamin

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. Freemanand Company,
6. Willey MJ, Sherwood, LM &Woolverton C J (2013) Prescott, Harley and Klein's Microbiologyby. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

CMc-102: CELL BIOLOGY (THEORY)
SEMESTER –I **Full marks 75**

TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 Structure and organization of Prokaryotic Cell (8 Periods)

Prokaryotic 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), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

UNIT II **(8 Periods)**

Basics of Cell Biology (structure & function) – Discovery of cell and Cell Theory;
Comparison between plant and animal cells; cytosol, compartmentalization of eukaryotic cells, cell fractionation.
Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.
Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Cytoskeleton;
Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex;

UNIT II **(12 Periods)**

Membrane Vacuolar system, cytoskeleton and cell motility : Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation.
Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III **(12 Periods)**

Lysosomes: Vacuoles and micro bodies: Structure and functions
Ribosomes: Structures and function including role in protein synthesis.
Mitochondria: Structure and function, Genomes, biogenesis.
Chloroplasts: Structure and function, genomes, biogenesis
Nucleus: Structure and function, chromosomes and their structure.

UNIT IV **(20 Periods)**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer,

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

CMc-192: CELL BIOLOGY (PRACTICAL)
SEMESTER –I **Full marks 25**

TOTAL HOURS: 40 **CREDITS: 2**

1. Study a representative Bacteria, plant and animal cell by microscopy.
23. Cytochemical staining of DNA – Feulgen
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

SUGGESTED READING

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Ability enhancement course AECMc

AECMc 101 English Communication

Total Marks-50

Credit-2

Lecture Hour-
40L+Practicals 20L

1. Communication and communicative activities of the notions of encoder and decoder and the message and the medium **5Periods**

2. Concise grammatical structures and key vocabulary for general as well as specific purpose accuracy and appropriateness in the use of English. **6 Periods**

3. English speech sounds and sound combinations. **4 Periods**

4. Elements of Spoken English. **4 Periods**

5. Topic of discourse, mode of discourse and style of discourse with special reference to scientific discourse. **4 Periods**

6. Writing notes, reports, proceedings etc. **4 Periods**

7. Expanding and summarizing. **3 Periods**

8. Narrating and describing. **5 Periods**

9. Tutorial for each topic. **5 Periods**

Practical

Practical on all language activities and communicative tasks- group discussion, seminar

AECMc - COMPUTER FUNDAMENTALS **Total Marks-50**

Credit-2

Lecture Hour- 40L

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

UNIT 1: Basic concept of Computer System 4L

Introduction, Characteristics of Computer, Components of Computer, Basic organization of Computer System (I/P, O/P, Memory & CPU units).

Generation of Computer: 1st to 4th generations with characteristics.

UNIT 2: Operating System

Introduction 2L

What operation systems do? Operations of OS. Evolution of OS – Batch processing, Multiprogramming, Time sharing, Distributed.

Process Management 12L

Process concept, Process States, Process control block (PCB)

Process scheduling: Schedulers (long-term, short-term and medium-term), Context switching, scheduling criteria, scheduling algorithms (FCFS, SJF, Priority, RR), Multilevel Queue scheduling and Multilevel Feedback Queue scheduling.

Threads: Concept, Models, Multi-threading example (word processor).

Process Synchronization: Cooperating process, Critical-Section problem and solution, Semaphores (Binary & counting).

Deadlocks: Concept, Resource Allocation Graph, Necessary conditions for Deadlock, Handling deadlocks: Deadlock prevention and avoidance. Concept of Banker's algorithm with example, Deadlock recovery.

File Management 4L

File concepts: File attributes, File types, File operations and File structure. File accessing methods (sequential and direct). File directories type (single-level, two-level and tree-level).

File mounting and file sharing. Implementation of Directory (Linear list and Hash list). File Allocation methods (contagious, linked and index).

UNIT 3: Digital Logic 12L

Number System: Positional & Non-Positional, Representation of positional number system, Classification of positional number system (Decimal, Binary, Octal, Hexadecimal).

Inter-conversion: among known and unknown bases.

Digital Logic: addition, subtraction, multiplication, division, r's complement & (r-1)'s complement.

Boolean Algebra & Logic Gates

Basic laws and postulates, Huntington postulates, Duality.

Logic Gates: AND, OR, NOT, NAND, NOR, XOR & XNOR with truth table.

Boolean Functions: Representation (Boolean expression, Truth Table & Circuit Diagram), Canonical Form (SOP, POS), Conversion between canonical forms.

UNIT 4: Basic Computing Lab

Basic Operating System Commands 3L

- Listing directory contents, creating directory, changing directory.
- Creating file, copying & moving files, renaming & removing files.
- Date & time commands.
- Pipe & batch command concepts.

Familiar with OS interface 1L

- Customising desktop, arranging files & directories etc.

Office applications 2L

- Word Processor Application
- Spreadsheet Application
- Presentation Application

Reference Books:

- Computer Fundamentals – by Pradeep K Sinha, Priti Sinha
- Operating System Concepts – by Abraham Silberschatz, Peter B. Galvin, Gerg Gange
- Operating System – by P. Bala Krishna Prasad
- Digital Design - by M. Morris R. Mano (Author), Michael D. Ciletti (Author)
- Digital Logic and Computer Design – by M. Morris Mano

Tosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions,

conservation of biodiversity, *in-situ* and *ex-situ* conservation of biodiversity, concept of sustainability and sustainable development.

UNIT II **(18 Periods)**

Natural resources & its management and conservation: Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non renewable energy sources, use of alternate energy sources and growing energy needs.

UNIT III **(11 Periods)**

Environmental pollution & management: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain and their impact on human communities and agriculture. Environment Laws: Environment Protection

Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT IV **(6 Periods)**

Environment & social issues: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; environmental communication and public awareness.

Learning resources

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.

2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.

3. Gleeson, B. and Low, N . (eds.) 1999. *Global Ethics and Environment*, London, Routledge.

4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.

6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,*339: 36-37.

7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.

8. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

9. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.

10. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.

11. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.

12. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.

13. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and*

14. *CSthooedn Thsrei,or vpNai.ctSiso.., n* JG.o Shibn. s CWohnai,l neLdy. P&&u bSRloiasnvhsei. nn g, ,P N.Hew. (Dedesl)h.i .2 013. *Conservation Biology*: *Voices from*

15. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.

16. World Commission on Environment and Development. 1987. *Our Common Future*.

Oxford University Press.

GEMc-101: INTRODUCTION AND SCOPE OF MICROBIOLOGY (THEORY)
SEMESTER –I **Full marks 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 History of Development of Microbiology **No. of Hours: 12**

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of 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 **No. of Hours: 10**

Characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular 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 **No. of Hours: 7**

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

Unit 4. Sterilization **No. of Hours: 5**

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

Unit 5. Microbes in Human Health & Environment **No. of Hours: 10**

Medical microbiology and immunology: example of common human diseases and their causative agents. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types.

Environmental microbiology: Definitions of environment and examples of important microbes in soil, water and sediments covering the planet.

Unit 6 Industrial Microbiology **No. of Hours: 8**

Definition of fermentation, primary and secondary metabolites

Unit 7 Food and Dairy Microbiology **No. of Hours: 8**

Examples of microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

GEMc -101.1: INTRODUCTION AND SCOPE OF MICROBIOLOGY (PRACTICALS)
SEMESTER –I **Full marks 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Microbiology Laboratory Management 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. Sterilization of medium using Autoclave and assessment for sterility
4. Sterilization of glassware using Hot Air Oven and assessment for sterility
5. Sterilization of heat sensitive material by filtration and assessment for sterility
6. Study of different shapes of bacteria using permanent slides
7. Study of *Rhizopus* and *Penicillium* using permanent mounts
8. Study of *Spirogyra* and *Chlamydomonas* using permanent Mounts
9. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

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). General Microbiology. 5th edition. McMillan.

GEMc -102: MICROBES IN ENVIRONMENT (THEORY)
SEMESTER – I **Full marks 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 Microbes in Terrestrial Environment **No. of Hours: 10**

Components of microbial ecosystem, Lithosphere and its microbial diversity, Soil composition and its profile, Formation of different soils, Soil as nutrient resource, Shallow and deep subsurface microbiology, General characteristic and activity of microbes in porous medium.

Unit 2 Microbes in Aquatic Environment **No. of Hours: 12**

Natural Water: Atmosphere, surface, Stored & Ground water. Zonation of water ecosystem, upwelling, eutrophication; food chain in aquatic ecosystems. Water as a Microbial Habitat, Physiological factors in aquatic environment: Temperature, Hydrostatic pressure, Light, Salinity, Turbidity, pH, inorganic & organic constituents, BOD and COD, Microorganisms in Marine Ecosystems- Costal region, Open Ocean, Benthic Marine Environments, estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs, Microorganisms in Freshwater Ecosystems-glacier, Stream and lake. Role of methanotrophs in ecosystem, Ground water types and their contamination. Biofilm formation.

Unit 3 Microbes in Atmosphere **No. of Hours: 8**

The atmosphere and aerosols, Nature of Bioaerosols, Aeromicrobiological pathway- launching, transport and deposition of microbes, Microbial Survival in the Air, Extramural and Intramural aeromicrobiology, Bioaerosol control- Ventilation, Filtration, biocidal control, isolation.

Unit 3 Microbes in Zoonotic Environment **No. of Hours: 6**

Microbes in/on human body (Microbiomics) & animal (ruminants) body.

Unit 4 Microbes in Extreme Habitats **No. of Hours: 5**

Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Unit 5 Microbial Interactions **No. of Hours: 5**

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 6 Biogeochemical Cycling **No. of Hours: 14**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, starch, lignin, pectin and chitin.
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
Phosphorus cycle: Phosphate immobilization and solubilisation.
Sulphur cycle: Microbes involved in Sulphur.

GEMc -102.1: MICROBES IN ENVIRONMENT (PRACTICAL)
SEMESTER –I **Full marks 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.
6. Isolation of microbes (bacteria & fungi) from atmosphere.

SUGGESTED READINGS

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, AcademicPress
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
Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial
Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. NewYork & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,Cambridge, England.
11. Subba Rao 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.

GEMc -103 BIOMATHEMATICS AND BIOSTATISTICS (THEORY)
SEMESTER –I **Full marks 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 Classical Algebra **No of Hours: 18**

Complex Number including D'Moivre's Theorem, Logarithm (only algebra, without Series expansion), Binomial Theorem (without infinite series).
Determinant, Matrix, Rank of Matrices by Diagonalisation method. (12 Periods)

Unit 1I Calculus – I [For functions of single variable] **No of Hours: 20**

Limit, Continuity, Differentiation (including differentiability), Successive Differentiation, Expansion of Functions – Rolle's theorem, Mean Value theorem, Integration – Definite and

Indefinite (ordinary, method of substitution, special trigonometric function, partial fraction) Application of integration to find area, Differential equations --homogeneous and Linear ODE's and its simple applications to biological problems. (20 Periods)

Unit III Calculus – II [For functions of two variables] No of Hours: 10

Partial Differentiation including Euler's theorem and it's application.

Unit IV Biostatistics No of Hours: 12

Principles of statistical analysis of biological data.
Conceepts of Mean, Median, Mode from grouped and ungrouped Data set
Sampling parameters. Difference between sample and Population, Sampling Errors, Small sample test based on t-test, Z- test and F test; Distribution-free test - Chi-square test;

GEMc -103.1 BIOMATHEMATICS AND BIOSTATISTICS (PRACTICAL)
SEMESTER I Full marks 25
TOTAL HOURS: 40 CREDITS: 2

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc;
2004.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

SEMESTER II

CMc-201: INTRODUCTION TO MICROBES AND MICROBIAL DIVERSITY (THEORY)
SEMESTER –II **Full Marks: 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1. Systems of classification **No. of Hours: 14.**

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

Unit 2. Important archaeal and eubacterial groups **No. of Hours: 16**

Archaebacteria: General characteristics, phylogenetic overview, economic importances of genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens(*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium, Halococcus*)]

Eubacteria: Morphology, ecological significance and economic 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

Unit 3 Bacteriological techniques **No. of Hours: 5**

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

Unit 4. Reproduction in Bacteria **No. of Hours: 3**

Asexual methods of reproduction, Binary fisson and and its consequences, phases of growth,

Unit 5. Eukaryotic Microorganisms. **No. of Hours: 15**

• 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 lifecycles.

• 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..

• Protozoa

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

Unit 6. Media **No. of Hours: 2**

Chemically defined media, Complex media

Unit 7. Staining techniques **No. of Hours: 2**

Theories of staining, Staining reagents, auxochrome, chromophore, dye. Classification of stains, Biochemical mechanisms of negative staining, staining grams staining, acid fast staining, capsule staining, flagella staining, and endospore staining.

Unit 8. Physical and Chemical methods of microbial control **No. of Hours: 3**

Sterilization dry and moist heat, tyndalisation pasteurization, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation, ultrasonication
Chemical methods of microbial control: disinfectants, types and mode of action.

CMc 291: INTRODUCTION TO MICROBES AND MICROBIAL DIVERSITY (PRACTICAL)
SEMESTER –II **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Preparation of different media: Nutrient agar, Complex media- McConkey agar, EMB agar. YEPD Agar, Sabraud's Chloramphenicol agar, synthetic media BG-11
2. Isolation of pure cultures of bacteria by streaking, spreading, pore plate method.
3 Estimation of CFU count by spread plate method/pour plate method
4. Motility by hanging drop method.
5. Preservation of bacterial cultures by various techniques
6. Staining: Simple staining, Negative staining, Gram's staining, Acid fast staining-permanent slide only. Capsule staining, Endospore staining.
7. Sterilization of medium using Autoclave and assessment for sterility
8. Sterilization of glassware using Hot Air Oven and assessment for sterility
9. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
10. Determination of phenol coefficient of disinfectants

SUGGESTED READINGS

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 editionMcMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition PearsonEducation.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. PearsonEducation Limited

CMc-202: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)
SEMESTER –II **Full Marks: 75**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth No. of Hours: 18

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.

Unit 2 Nutrient uptake and Transport No. of Hours: 4

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 No. of Hours: 16

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 No. of Hours: 6

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction).Methanogenesis.
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 No. of Hours: 10

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanotrophy and methylotrophy (definition and reactions)
Introduction to phototrophic metabolism - groups of phototrophic microorganisms,
Anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purplebacteria and cyanobacteria

Unit 6. Sulphur Metabolism - No. of Hours: 6
Oxidation of reduced Sulphur compounds, Sulphate reduction,

CMc-292: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)
SEMESTER –II Full Marks: 25
TOTAL HOURS: 40 CREDITS: 2
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 pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7.Demonstration of the thermal death time and decimal reduction time of *E. coli.*

SUGGESTED READINGS
1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. PrenticeHall 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
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition,McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

CMc-203: FOOD AND DAIRY MICROBIOLOGY (THEORY)
SEMESTER –II Full Marks: 75
TOTAL HOURS: 60 CREDITS: (3+1) =4
Unit 1 Foods as a substrate for microorganisms No. of Hours: 15
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general, Water in food, water activity and shelf life of food, Carbohydrates-chemical reactions, functional properties of sugars and polysaccharides in foods, Lipids: classification, and lipids-chemical reactions in foods, Protein and amino acids distribution, Protein -chemical reactions and functional properties of proteins in foods.

Unit 2. Microbial spoilage of various foods **No. of Hours: 10**

Food contaminants and spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods.

Unit 3. Milk and dairy products

Types of Milk, cream, eggnog, buttermilk, butter, cheese, ice-cream. Reactions of milk, Microorganisms present in the milk and their characteristics. milk standards, pasteurization, milk born infections

Unit 4 Principles and methods of food preservation **No. of Hours: 15**

Physical methods of food preservation: temperature (low, high, canning, drying), additives, irradiation, hydrostatic pressure, high voltage pulse, extrusion cooking, microwave processing dielectric heating, and aseptic packaging,

Chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit 5. Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **No. of Hours: 15**

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 5 Food sanitation and control **No. of Hours: 5**

HACCP, Indices of food sanitary quality and sanitizers

CMc-293: FOOD AND DAIRY MICROBIOLOGY (PRACTICAL)
SEMESTER –II **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of food borne bacteria and fungi from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

SUGGESTED READINGS

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. CABInternational, 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.
ofFoods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. PearsonEducation.

AECCSecond semester

AECMc201 - COMPUTER FUNDAMENTALS **Total Marks-50**

Credit-2

Lecture Hour- 40L

UNIT 1: Basic concept of Computer System 4L
Introduction, Characteristics of Computer, Components of Computer, Basic organization of Computer System (I/P, O/P, Memory & CPU units).
Generation of Computer: 1st to 4th generations with characteristics.
UNIT 2: Operating System
Introduction 2L
What operation systems do? Operations of OS. Evolution of OS – Batch processing, Multiprogramming, Time sharing, Distributed.
Process Management 12L
Process concept, Process States, Process control block (PCB)
Process scheduling: Schedulers (long-term, short-term and medium-term), Context switching, scheduling criteria, scheduling algorithms (FCFS, SJF, Priority, RR), Multilevel Queue scheduling and Multilevel Feedback Queue scheduling.
Threads: Concept, Models, Multi-threading example (word processor).
Process Synchronization: Cooperating process, Critical-Section problem and solution, Semaphores (Binary & counting).
Deadlocks: Concept, Resource Allocation Graph, Necessary conditions for Deadlock, Handling deadlocks: Deadlock prevention and avoidance. Concept of Banker's algorithm with example, Deadlock recovery.

File Management 4L

File concepts: File attributes, File types, File operations and File structure. File accessing methods (sequential and direct). File directories type (single-level, two-level and tree-level). File mounting and file sharing. Implementation of Directory (Linear list and Hash list). File Allocation methods (contagious, linked and index).

UNIT 3: Digital Logic 12L

Number System: Positional & Non-Positional, Representation of positional number system, Classification of positional number system (Decimal, Binary, Octal, Hexadecimal).
Inter-conversion: among known and unknown bases.
Digital Logic: addition, subtraction, multiplication, division, r's complement & (r-1)'s complement.
Boolean Algebra & Logic Gates
Basic laws and postulates, Huntington postulates, Duality.
Logic Gates: AND, OR, NOT, NAND, NOR, XOR & XNOR with truth table.
Boolean Functions: Representation (Boolean expression, Truth Table & Circuit Diagram), Canonical Form (SOP, POS), Conversion between canonical forms.

UNIT 4: Basic Computing Lab

Basic Operating System Commands 3L

- Listing directory contents, creating directory, changing directory.
- Creating file, copying & moving files, renaming & removing files.
- Date & time commands.
- Pipe & batch command concepts.

Familiar with OS interface
1L

- Customising desktop, arranging files & directories etc.

Office applications
2L

- Word Processor Application
- Spreadsheet Application
- Presentation Application

Reference Books:

- Computer Fundamentals – by Pradeep K Sinha, Priti Sinha
- Operating System Concepts – by Abraham Silberschatz, Peter B. Galvin, Gerg Gange
- Operating System – by P. Bala Krishna Prasad

- Digital Design - by M. Morris R. Mano (Author), Michael D. Ciletti (Author)
- Digital Logic and Computer Design – by M. Morris Mano

AECMc202: Environmental Science

Total Marks-50

Credit-2

Lecture Hour-50L+Tutorials 10L

UNIT I **(15 Periods)**

Introduction to environmental studies & ecosystems: Multidisciplinary nature of environmental studies: Scope and importance; what is an ecosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, conservation of biodiversity, *in-situ* and *ex-situ* conservation of biodiversity, concept of sustainability and sustainable development.

UNIT II **(18 Periods)**

Natural resources & its management and conservation: Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non renewable energy sources, use of alternate energy sources and growing energy needs.

UNIT III **(11 Periods)**

Environmental pollution & management: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain and their impact on human communities and agriculture. Environment Laws: Environment Protection

Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT IV **(6 Periods)**

Environment & social issues: Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; environmental communication and public awareness.

Learning resources

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.

2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of

California Press.

3. Gleeson, B. and Low, N . (eds.) 1999. *Global Ethics and Environment*, London, Routledge.

4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev.,

Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.

5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of*

Conservation Biology. Sunderland: Sinauer Associates, 2006.

6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,*339: 36-37.

7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.

8. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

9. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.

10. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.

11. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.

12. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.

13. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and*

14. *CSthooedn Thsrei,or vpNai.ctSiso.., n* JG.o Shibn. s CWohnai,l neLdy. P&&u bSRloiasnvhsei. nn g, ,P N.Hew. (Dedesl)h.i .2 013. *Conservation Biology*: *Voices from*

15. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.

16. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

GEMc 201: INDUSTRIAL AND FOOD MICROBIOLOGY (THEORY)

SEMESTER – II **Full Marks: 75**
TOTAL HOURS: 60 **CREDITS: (3+1)**
=4

Unit 1 Introduction to Industrial microbiology **No. of Hours: 15**

Brief history and developments in industrial microbiology
Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous
Types of fermenters – laboratory, pilot-scale and production fermenters
Components of a typical continuously stirred tank bioreactor

Unit 2 Isolation of Industrial Strains and Fermentation Medium **No. of Hours: 8**
Primary and secondary screening. Preservation and maintenance of industrial strains
Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Unit 3 Microbial fermentation processes **No. of Hours: 15**
Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.
Microbial production of industrial products - citric acid, ethanol and penicillin.
Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Unit 4 Fermented foods **No. of Hours: 10**
Dairy starter cultures, fermented dairy products: yoghurt, acidophilus milk, kumiss, kefir, curds and
cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit 5 Food packaging: **No. of Hours: 12**

Introduction to packaging, Packaging operation, package-functions and design, Principle in the development of protective packaging, Deteriorative changes in foodstuff and packaging methods for prevention, shelf life of packaged foodstuff, methods to extend shelf-life, Food containers-rigid containers, corrosion of containers (Tin plate), Flexible packaging materials and their properties, Food packaging materials and their properties, Food packages-bags, pouches, wrappers, carton and other traditional package, Biodegradable packaging.

GEMc291: INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)
SEMESTER – II **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**
1. Microbial fermentation for the production and estimation of amylase
2. Microbial fermentation for the production and estimation of citric acid
3. Microbial fermentation for the production and estimation of ethanol
4. Determination of the microbiological quality of milk sample by MBRT
5. Isolation of bacteria,fungi, actinomycetes from spoilt bread/fruits/vegetables
6. Preparation of Yogurt/Dahi

SUGGESTED READING
1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd

Edition. Panima Publishing Company, New Delhi
2. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson
Education
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology.9th Edition. McGraw Hill Higher education
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition,
Elsevier Science Ltd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P)
Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
10. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.

GEMc-202: CHEMISTRY I (THEORY)
SEMESTER –II **Full Marks: 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

1. **Atomic Structure:** **No. of Hours: 6**

Bohr's atomic model & limitation. Idea of de Broglie matter weaves. Hisenberg's uncertainty principle. Schrodinger's wave equation. Significance of wave function. Quantum numbers. Multi electron system-Pauli's exclusion principal, Hunds rules of maximum multiplicity. Stability of halffilled full field orbitals, Aufbau principal & its limitation. Electronic configuration of atoms.

2. **Radioactivity and Nuclear Structure of Atoms:** **No. of Hours: 6**

Radioactive disintegration series, group displacement law, law of radioactive decay, half-life and average life of radio elements, radioactive equilibrium, and measurement of radioactivity. Stability of atomic nucleus, n/p ratio. Radioisotopes and their application: Determination of age of earth, radio carbon dating, Medicinal and agriculture use of isotopes, hazards of radio activity.

3. Chemical Bonding and Structure: **No. of Hours: 6**

(a) Ionic Bonding: General characteristics of ionic compounds: ionization energy, electron affinity etc. Sizes of ions, radius ratio rule and its limitation. Lattice energy, Born-Haber cycle.
(b) Covalent Bonding: General characteristics of covalent compounds, valence bond approach, directional character of covalent bond, hybridization involving s-, p- and d- orbitals. Valence State Electron Pair Repulsion (VSEPR) concept, shapes of simple molecules and ions. Fajan's Rules. Hydrogen bonding and its effect on physical and chemical properties. Others types of molecular interaction.

4 Acids-Bases and Solvents **No. of Hours: 5**

Modern concepts of acids and bases: Arrhenius theory, theory of solvent syst em, Bronsted and Lowry's concept, Lewis concept with typical examples, applicationsnand limitations. Strengths of acids and bases (elementary idea). Ionization of weak acids and bases in aqueous solution, ionization constants, ionic product of water, pH scale

5. Nomenclature and Bonding in organic compounds: **No. of Hours: 5**

Classification, trivial names and IUPAC system of nomenclature of organic compounds. Nature of covalent bond and its orbital representation. Hybridization, bond energy, polarity of bond & dipole moment of molecules, inductive effect, hydrogen bond, conjugation, resonance. Haemolytic & heterolytic fission of bonds electrophiles & nucleophiles, carbocation, carbanions and radicals- there stability, geometry & generation.

6. Alkanes, Alkenes, Alkynes: **No. of Hours: 5**

Isomerism, synthesis, chemical reactivity of alkanes, Mechanism of free radical halogenation of alkanes, sulphonation of alkanes. Chemical reactivity, hydrogenation, heat of hydrogenation and stability of alkanes, electrophilic addition reaction & mechanism, halogenation, hydrohalogenation, hydration, hydroboration, Markownikoffs rule, peroxide effect, 1-3 dipolar addition (only formation no details mechanism is required). Alkyne synthesis hydration, substitution reactions, polymerization.
Mechanism of SN1 & SN2 reaction, E1&E2 reaction (elementary treatment) of aliphatic hydrocarbon. Saytzeff& Hofmann elimination.

7. Aromatics Hydrocarbons and Aromatic substitution reactions: **No. of Hours: 5**

Isomerism of aromatic compounds, their nomenclature, structure of benzene ring. General mechanism of aromatic electrophilic substitution (elementary treatment)

Methods of synthesis, nitration, Sulphonation, halogenation.Friedel-crafts alkylation and acylation, reaction, nuclear and side chain halogination..Mechanism of Nucleophilic and electrophilic aromatic substitution.

8 Stereochemistry: No. of Hours: 5

Dissymmetric Molecules: Different types of Isomerism,Structural Isomers, Geometrical, Stereoisomerism, Configurational Isomers, Conformational Isomers, Concept of asymmetric carbon atom, Enantiomers, Diastereiosmers, Stereogenic atom / center, Chirotopic / Achirotopic Centre, Protereoisomerism, Concept of Topicity of Ligands and Faces (Homotopic, Enantiotopic, Diastereotopic atoms and groups; Prochiral, Homotopic, Enantiotopic, Diastereotopic Faces), Projection Structures of Streoisomers (Fischer, Sawhorse, Newman, Flying-Wedge projection and Interconversion of these projections formulas) of simple molecules containing one or two asymmetric carbon atom, Optical isomerism, Optical activity, Element of symmetry and chirality, Meso compounds, Chiral centers and the number of stereoisomers, Racemic modifications, Racemic mixture or (+/-)-Conglomerate, Racemic Compounds or racenate, Stereochemical nomenclature of Stereoisomers containing chiral centers(R/S and E/Z or cis-trans or sec cis- sec trans of C=C system);D,L system of designation; Pro-R, Pro-S, Re, Si, Erythro, threo, Pref and Praf designation of enantiotopic groups and atoms; Chirality of Organic molecules without chiral center and concept of chiral axis.

9 .Alcohols, Ethers and phenols: No. of Hours: 5

Methods of synthesis, physical properties, distinction of primary, secondary and tertiary alcohols. Chemical reactivity. Ethers, methods of synthesis, Chemical reactivity. physical properties acidic character of phenols, chemical reaction –Reimer-Tiemann reaction, Fries rearrangement, Kolbe's reaction, phenol formaldehyde resins (Lederer-Manasse reaction) Cresols, nitro and amino phenols (Synthesis only).

10 Aldehydes and ketones: No. of Hours: 5

Methods of synthesis of aldehydes and ketones, chemical reactivity of carbonyl group, cannizzaro reaction and aldol condensation, relative reactivities of aldehyde and ketones. Perking reaction, benzoine condensation, Claisen condensation.

11 Carboxylic acid and their derivatives: **No. of Hours: 4**

Methodes of synthesis, acidity of aliphatic and aromatic acid, effects of substitutents on acidity (simple cases). Chemical reactivity. Mechanism of esterification. Methods of synthesis and reaction of acid halides, amides, esters and anhydrides.

GEMc-292: CHEMISTRY I (PRACTICAL)

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

SEMESTER – II **Full Marks: 25**

TOTAL HOURS: 40 **CREDITS: 2**

1. Qualitative organic analysis: **[30 lectures]**

Detection of elements (N, S, Cl, Br, I), unsaturation & all the functional groups (alcoholic & phenolic hydroxyl/ aldehydic & ketonic carbonyl / carboxylic acid & aromatic amino, anilide and nitro) present in a supplied mono- or bi- functional organic compounds.

2. Gravimetric Analysis: **[30 lectures]**

Techniques of Precipitations, filtration, washing, drying, igniting and weighing precipitates. Gravimatric estimation of any ion.

Determination of hardness water.

Estimation of glucose & phenol.

GEMc-203: INHERITANCE BIOLOGY (THEORY)

SEMESTER –II **Full Marks: 75**

TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1. Introduction to Genetics – **No. of Hours: 4**

An overview of modern history of Genetics before 1860, 1860-1900, 1900-1944, 1944-Present, About 3 general areas of Genetics (Classical, Molecular & Evolutionary).

Unit 2. Mendelian principle and Extension of Mendelism **No. of Hours: 8**

Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Inheritance patterns in Human (Sex-linked, Autosomal, Unifactorial, Multi-factorial). Deviation from Mendel's Dihybrid phenotype, Bateson & Punnet's Coupling & Repulsion hypothesis.

Unit 3Linkage & Crossing over- **No. of Hours: 8**

Chromosome theory of Linkage, kinds of linkage, linkage groups, Sutton's view on linkage, Morgan's view on linkage, types of Crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.

Unit4. Allelic Variation & Gene function– **No. of Hours: 6**

Multiple allele, Epiststic and Non-Epistatic inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.

Unit 5 Extra-chromosomal inheritance– **No. of Hours: 6**

Evidences for Cytoplasmic factors, cytoplasmic inheritance, extra-nuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance.

Unit 6. Chromosomal variation in Number & Structure– **No. of Hours: 10**

Euploidy, Non-disjunction & Aneuploidy, Aneuploid segregation in plants and animal, Polyploidy in Plants & Animals, Induced Polyploidy, applications of Polyploidy, Chromosomal Mosaics, Polytene chromosome in Diptera, structural chromosomal variation, Chromosomal aberrations & evolution.

Unit 7. Chromosome Mapping- **No. of Hours: 6**

Haploid mapping (2 point & 3 point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.

Unit8. Human Genetics– **No. of Hours: 6**

Human karyotype, Banding techniques, classification, use of Human Cyto-genetics in Medical science, , viable monosomies & trisomies, chromosomal deletions & duplications, genetics of chromosomal inversions & translocations, human traits,

Unit 9. Pedigree analysis– **No. of Hours: 6**

Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance.

GEMc-293: INHERITANCE BIOLOGY (PRACTICALS)
SEMESTER –II **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Preparation of Mitotic Chromosome from human Leucocytes.
2. Study of salivary gland chromosomes in Drosophila
3. Problems on Linkage and Crossing over in Eukaryotes
4. Tetrad Analysis in Neurospora /and Aspergillus
5. Study of Polyploidy in plants
6. Barr body / drumstick identification

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

SEMESTER III

CMc-301: MICROBIAL GENETICS (THEORY)
SEMESTER –III : **Full Marks: 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 Genome Organization and Mutations **No. of Hours: 18**

Genome organization: *E. coli, Saccharomyces, Tetrahymena*
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of Mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes

Unit 2 Plasmids **No. of Hours: 10**

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

Unit 3 Mechanisms of Genetic Exchange **No. of Hours: 12**

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 4 Phage Genetics **No. of Hours: 8**

Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected bacterial culture, Specificity in phage infection, *E. coli* PhageT4, *E.coli* phage lambda, Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor, Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles,

Unit 5 Transposable elements **No. of Hours: 12**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon
Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition

CMc-391: MICROBIAL GENETICS (PRACTICAL)
SEMESTER –IV **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

Maulana Abul Kalam Azad University of Technology, West Bengal

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

CMc-302: MOLECULAR BIOLOGY (THEORY)

SEMESTER –III: **Full Marks: 75**

TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 12**

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit 2 Replication of DNA (Prokaryotes and Eukaryotes) **No. of Hours: 10**

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, D- loop (mitochondrial), θ (theta) mode of replication and other accessory protein, Mismatch and excision repair

Unit 3 Transcription in Prokaryotes and Eukaryotes **No. of Hours: 8**

Transcription: Definition, difference from replication, promoter - concept and strength of promoter

RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors

Unit 4 Post-Transcriptional Processing **No. of Hours: 8**

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA,

miRNA and its significance

Unit 5 Translation (Prokaryotes and Eukaryotes) **No. of Hours: 10**

Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote

Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes **No. of Hours: 12**

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp,* ara
operons, Sporulation in *Bacillus,* Yeast mating type switching , Changes in Chromatin Structure -
DNA methylation and Histone Acetylation mechanisms.

CMc-392: MOLECULAR BIOLOGY (PRACTICAL)
SEMESTER –III: **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A_{260} measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A_{260} measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

SUGGESTED READINGS

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. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett
Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

CMC-303: ENVIRONMENTAL MICROBIOLOGY (THEORY)

SEMESTER –III : **Full Marks: 50**

Maulana Abul Kalam Azad University of Technology, West Bengal

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BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1 Microorganisms and their Habitats **No. of Hours: 16**

Structure and function of ecosystems
Terrestrial Environment: Soil profile and soil microflora
Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aeromicroflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiomics) & 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 **No. of Hours: 10**

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 **No. of Hours: 14**

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 solubilisation
Sulphur cycle: Microbes involved in sulphur cycle
Other elemental cycles: Iron and manganese.

Unit 4 Waste Management **No. of Hours: 7**

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 **No. of Hours: 8**

Principle and types of bioremediation. Overview on the microbial bioremediation of inorganic (metals) matter and biodegradation of common organic pollutants (pesticides, hydrocarbons, and, biosurfactants).

Unit 6 Water Potability **No. of Hours: 5**

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

CMc-393: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)
SEMESTER –IV Full Marks: 25
TOTAL HOURS: 40 CREDITS: 2

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

SUGGESTED READINGS

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.
10. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
11. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
12. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
13. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

SECMC-301: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER
SEMESTER – III **Full Marks: 50**
TOTAL HOURS: 40 **CREDITS: 2**

Unit 1 Aeromicrobiology **No of Hours: 4**
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 **No of Hours: 7**
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi,
Identification characteristics

Unit 3 Control Measures **No of Hours: 4**
Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology **No of Hours: 4**
Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water **No of Hours: 7**
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

Unit 6 Control Measures **No of Hours: 4**

Precipitation, chemical disinfection, filtration, high temperature, UV light

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

SECMC-302: BIOFERTILIZERS AND BIOPESTICIDES
SEMESTER – III **Full Marks: 50**
TOTAL HOURS: 40 **CREDITS: 2**

Unit 1 Biofertilizers **No of Hours: 10**

General account of the microbes used as biofertilizers for various crop plants and their advantages
over chemical fertilizers.
Symbiotic N2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants
Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis.
Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2 Non - Symbiotic Nitrogen Fixers **No of Hours: 4**

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production
and field application.

Unit 3 Phosphate Solubilizers **No of Hours: 4**

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

Application

Unit 4 Mycorrhizal Biofertilizers **No of Hours: 5**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides **No of Hours: 7**

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides,
Bacillus thuringiensis, production, Field applications, Viruses – cultivation and field applications.

Suggested Readings

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.
1. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic

SECMC-303: FOOD FERMENTATION TECHNIQUES
SEMESTER – III **Full Marks: 50**
TOTAL HOURS: 40 CREDITS: 2

Unit 1 Fermented Foods No of Hours: 4

Definition, types, advantages and health benefits

Unit 2 Milk Based Fermented Foods No of Hours: 8

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Unit 3 Grain Based Fermented Foods No of Hours: 6

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

Unit 4 Vegetable Based Fermented Foods No of Hours: 4

Pickels, Saeurkraut: Microorganisms and production process

Unit 5 Fermented Meat and Fish No of Hours: 4
Types, microorganisms involved, fermentation process

Unit 6 Probiotic Foods No of Hours: 4
Definition, types, microorganisms and health benefits

Suggested Readings
1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and
fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology,
Metropolitan

GEMc-301 BIOMOLECULE METABOLISM (THEORY)

SEMESTER –III : **Full Marks: 75**

TOTAL HOURS: 60 **CREDITS: (3+1) =4**

Unit 1: Carbohydrate Metabolism :
Conversion of polysaccharide to glucose – 1 – phosphate, Glycolysis and fermentation and their regulation, Gluconeogene sis and glycogenolysis, Metabolism of galactose and galactosemie, Role of sugar nuclectides in biosynthesis and Pentosephosphate pathway.

Unit II: The Citric Acid Cycle :
Significance, reactions and energetic of the cycle, Amphibolic role of the cycle, and Glyoxalic acid cycle.

Unit III: Lipids Metabolism :
Oxidation of fatty acids, α-oxidation & energetic, β-oxidation, ω-oxidation, Biosynthesis of ketone bodies and their utilization, Biosynthesis of saturated and unsaturated fattyacids, Control of lipid metabolism, Essential fattyacids & eicosanoids (prostaglandins, thromboxanes and leukotrienes) phospholipids, and sphingolipids.

Unit 1V: Nucleic acid metabolism
Metabolism of pyrimidine and purine nucleotides

Unit V: Biological Oxidation

Redox-Potential, enzymes and co-enzymes involved in oxidation reduction & its control, The respiratory chain, its role in energy capture and its control, Energetic of oxidative phosphorylation, Inhibitors of respiratory chain an d oxidative phosphorylation, Mechanism of oxidative phosphorylation. Production of ATP and its biological significancance

GEMc-391 BIOMOLECULE METABOLISM (PRACTICAL)
SEMESTER –III **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Experiments of sugar – test for reducing sugar, colorometric estimation of sugar, chromatographic
separation of sugars.
2. Titration curve for amino acids
3. Separation of amino acids by TLC method.
4. Experiments on lipids – saponification no., iodine no., separation of lipids by TLC.
5. Quantitative estimation of amino acids, protein,
6. Experiments on clinical bio-chemistry – blood glucose estimation, cholesterol in blood, separation
of plasma proteins by paper electrophoresis, non-protein N – in blood, estimation of SGOT, SGPT
and ALP in the serum.
7. Experiments on enzymes – effect of pH, effect of temperature and use of inhibit

GEMc-302 CHEMISTRY II
SEMESTER – III **Full Marks: 75**
TOTAL HOURS: 60
CREDITS: 4

Unit 1: Chemical analysis : **No of Hours: 10**

i) Comparative study of the following groups of elements:
(a) B, Al (b) C, Si, Ge, Sn, Pb (c) N, P, As, Sb, Bi, (d) O, S, Se, Te (e) F,Cl, Br,I
In respect of electronic configuration, elemental states, oxidation states, hydrides, halides, oxides, and oxyacides.

Unit 2: Double & complex salt: **No of Hours: 5**

Werner's theory of co-ordination compounds. Chelates. Polydentate ligands including naturally occurring ones. Electronic interpretation of compounds formation. Stepwise and overall stability constants. (elementary idea only) Geometrical & optical isomerism. Nomenclature of coordination compounds.

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Unit 3: Interhalogen compounds: **No of Hours: 5**

Basic properties of iodine, pseudo halogens.

Unit 4: Organometallic Compounds: **No of Hours: 5**

Organomagnesium Compounds, Organozinc Compounds, Organolead Compounds, Organocadmium Compounds.

Unit 5: Bio-inorganic chemistry **No of Hours: 5**

Role of metal complexes in biological system : Role of Iron and Magnesium

Unit 6: Ideal and real Gases : **No of Hours: 5**

Distribution of molecular velocities, root-mean-square velocity, kinetic molecular theory of ideal gases, deduction of kinetic gas equation. $P=\frac{1}{3}mnc^2$, deduction of gases laws. Deviations of real gas from ideal behavior, vander waal's equation. Andrews exprement, critical phenomena in light of vander waal's equation of state, law of corresponding state.

Unit 7: Thermodynamics and Homogeneous chemical equilibrium: **No of Hours: 10**

Cyclic process, Reversible & irreversible process , internal energy, enthalpy, work Done, an isothermal & adiabatic process, heat capacities, Cp-Cv =R for an ideal gas. Thermochemistry, Carnot cycle, Elementary treatment of entropy, free entry, work function & criterion of equilibrium. Gibbs Helmohltz equation, Clasious Clapeyron equation and its application. Law of mass action and equilibrium constant Kp,Kc,Kx and their relationship. *Le-chatelier's* principal- effect of temperature, pressure and addition of products and inert gases. vant's hoff equation (derivation not required) and its application.

Unit 8: Solubility and Ionic Equilibrium: **No of Hours: 5**

Solubility product, common ion effect and factors of solubility. Strong and weak electrolytes degree of dissociation. Ostwald's dilution law. Hydrolysis, buffer, calculation of pH, salt effect, elementary idea of activity & activity co-efficient of electrolytes, ionic strength, buffer reaction of blood.

Unit 9: EMF : **No of Hours: 5**

Electrochemical cells, half-cell, electrode potential, standard electrode potential, Nernst equation, redox potential, reference electrode,standered cell, measurement of emf, determination of pH, potentiometric titration, storage battery, corrosion.

Unit 10: Dilute solution: **No of Hours: 5**

Rault's law, ideal solution, non- ideal solution, and qualitative treatment of colligative properties relative lowering of vapour pressure, elevation of boiling point, and osmotic pressure-their application in finding molecular weight. Van't Hoff 'i' factor, plasmolysis, haemolysis, isotonic solution, normal saline, role of osmosis in living organism.

SUGGESTED READING

1. Inorganic Chemistry by R. L. Dutta
2. Organic Chemistry by I. L. Finer (vol. I)
3. Physical chemistry by P. C. Rakshit

GEMc-392 CHEMISTRY II (PRACTICAL)
SEMESTER – III **Full Marks: 25**
TOTAL HOURS: 40 **CREDITS: 2**

1. Qualitative inorganic analysis **No of Hours: 20**

Systematic semi micro quantitative analysis of simple mixture containing one basic radical and one acid radical from the following list (Spot test are to be applied whenever possible) lead, mercury, copper, arsenic, antimony, tin, iron, aluminum, chromium, zinc,manganese, cobalt, nickel, calcium, strontium, barium, magnesium, sodium, potassium, ammonium, &other oxides, chlorides, bromides, iodides, sulphaides, sulphites, sulphates, nitrites, nitrates, nitrites, & phosphates, (Acid insoluble compounds & phosphate separation omitted).

2. Quantitative inorganic analysis **No of Hours: 20**

Preparation and standardization Mohr's solution by KMnO4 solution.
Estimation of Fe(II) +Fe (III) mixture using standard solution of K2Cr2O7
Determination of Cu (II) using standard sodium thiosulphate solution

3. Determination of physical parameters **No of Hours: 20**

To determine the percentage composition of given mixture from viscosity measurement.
To determine the percentage composition of given mixture by surface tension method.
To study the distribution of benzoic acid between benzene and water and determination of partition coefficient
To determine the pH of a given solution using bromocresol green/ methyl red indicator.

SUGGESTED READING

1. Inorganic Chemistry by R. L. Dutta
2. Organic Chemistry by I. L. Finer (vol. I)
3. Physical chemistry by P. C. Rakshit
4.. Advanced practical chemistry, 3rd edition by Subhas C Das

5 An advanced course in practical chemistry by Ghoshal, Mahapatra and Nad.

GEMc-303 BIOLOGICAL DIVERSITY AND TAXONOMY
SEMESTER – III **Full marks 75**
TOTAL HOURS: 60 **Credit 4 (3+1**

Basic concept of Biodiversity – What is Biodiversity, Why should we conserve it, Elements of Biodiversity - Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity. **(5Periods)**

Global patterns of Biodiversity – measuring biodiversity, Cataloging and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species), GAP Analysis.

(7Periods)

Biodiversity & Conservation – Overexploitation threatening living species, International Trade, Animals threatened by International trade, Problems in Controlling International Trade (Enforcement, Reservations, Illegal Trade), Free Trade & the Environment, Free Trade & Conservation, Common patterns of Overexploitation. **(8 Periods)**

Exotic Species – Introduction, types Plants, Invertebrates, Fishes, Amphibians, Reptiles, Birds, Mammals, Detrimental Effects of Exotic Species. **(3 Periods)**

Endangered Species Conservation – The US Endangered Species Act, State Endangered Species Acts Successes and Failures of the Endangered Species Act Role of ESA in Habitat Protection, Critical Habitat, Problems with the Endangered Species Act, Habitat Conservation Plans. **(6 Periods)**

Ethics of Conservation – Values of Biodiversity, Biopiracy, Hybridized plants, GM crops (benefits & criticism), Economic Value of Biodiversity & Legal, Ethical and Conservation issues related to uses of biodiversity, Global Conservation Issues. **(8 Periods)**

Taxonomy

Basic concept of Taxonomy – Classification, Construction of Phylogenetic tree, Systematics,

Cladistics, Cladograms, Phenetics, Nomenclature. **(5 Periods)**

Taxonomy in relation to Chromosomal morphology & Evolution – Chromosomal evolution, why location of genes matter, evolutionary oddities about chromosomes, evolutionary effect of rearrangements of chromosomes, karyotypic orthoselection, chromosomal evolution & speciation. **(8 Periods)**

Molecular Taxonomy in relation to DNA characteristics & Protein sequences – modes of molecular evolution, Neutral theory of Molecular evolution, genetic markers for taxonomic purposes, comparing total genome by DNA-DNA hybridization, comparing DNA sequences, Cladistics, biological identification through DNA barcodes, chromosome painting, establishing molecular homology using protein sequences. **(10 periods)**

GEMc-393: Lab on Biological Diversity and Taxonomy (Practical)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)
Total Marks-25

Credit: 2

Laboratory period: 40L

1. Assignments
2. Seminars

SEMESTER IV

CMc-401: IMMUNOLOGY (THEORY)
SEMESTER –IV Full Marks: 75
TOTAL HOURS: 60 CREDITS: 4

Unit 1 Introduction **No. of Hours: (3+1)= 4**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of 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 **No. of Hours: 4**
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 **No. of Hours: 2**
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 **No. of Hours: 3**
Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); Monoclonal and Chimeric antibodies

Unit 5 Major Histocompatibility Complex **No. of Hours: 4**
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 **No. of Hours: 4**
Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response **No. of Hours: 6**
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 **No. of Hours: 6**
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 and cancer.

Unit 9 Immunological Techniques **No. of Hours: 6**
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

Unit 10 Vaccines & Vaccination **No. of Hours: 6**

adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization, immunization programs & role of WHO in immunization programs.

CMc491:IMMUNOLOGY (PRACTICAL)
SEMESTER –IV Full Marks: 25
TOTAL HOURS: 40 CREDITS: 2

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Immunoelectrophoresis.

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. 6th edition W.H. Freeman and
Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science
Publishers, New York.
5. Peakman M, 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.

CMc-402 MEDICAL MICROBIOLOGY (THEORY)
SEMESTER –IV **Full Marks: 75**
TOTAL HOURS: 60 **CREDITS: (3+1)= 4**

Unit 1. Normal microflora of the human body and host pathogen interaction No. of Hours: 8

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin,
throat, gastrointestinal tract, urogenital tract
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. Bacterial diseases No. of Hours: 20
List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control
Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae, Mycobacterium tuberculosis*
Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*
Others: *Staphylococcus aureus, Bacillus anthracis, Clostridium tetani*, *Treponema pallidum, Clostridium difficie*

Unit 3. Viral diseases No. of Hours: 14
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

Unit 4. Protozoan diseases No. of Hours: 5
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 5. Fungal diseases No. of Hours: 5
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: Tinea pedis (Athlete's foot)
Systemic mycoses: Histoplasmosis
Opportunistic mycoses: Candidiasis

Unit 6. Antimicrobial agents: General characteristics and mode of action No. of Hours: 8

Antibacterial agents: Five modes of action with examples of each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism
Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin
Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine
Antibiotic resistance, MDR, XDR, MRSA, NDM-1

CMc-492: MEDICAL MICROBIOLOGY (PRACTICAL)
SEMESTER –IV **Full Marks: 25**
TOTAL HOURS: 40
CREDITS: 2

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
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.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

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 W oolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.
9th edition. McGraw Hill Higher Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

SECMC-401: MICROBIAL DIAGNOSIS IN HEALTH CLINICS

SEMESTER – IV **Full Marks: 50**

TOTAL HOURS: 40 **CREDITS: 2**

Unit 1 Importance of Diagnosis of Diseases **No of Hours: 6**

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit 2 Collection of Clinical Samples **No of Hours: 6**

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

Unit 3 Direct Microscopic Examination and Culture. **No of Hours: 8**

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria, Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit 4: Serological and Molecular Methods **No of Hours: 6**

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods -

PCR, Nucleic acid probes

Unit 5: Kits for Rapid Detection of Pathogens **No of Hours: 6**

Typhoid, Dengue and HIV, Swine flu

Unit 6: Testing for Antibiotic Sensitivity in Bacteria **No of Hours:8**

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution

Method

SUGGESTED READING

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities

Press Private Ltd.

2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and

Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication

3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd

edition, Elsevier India Pvt Ltd

4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby

5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical

SECMc 402: MANAGEMENT OF HUMAN MICROBIAL DISEASES
SEMESTER – IV Full Marks: 50
TOTAL HOURS: 40 CREDITS: 2

Unit 1 Human Diseases No of Hours: 6

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases,
occupational diseases, Incubation period, mortality rate, nosocomial infections

Unit 2 Microbial diseases No of Hours: 12

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin
diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical symptoms and general prevention methods, study of recent outbreaks of human diseases (SARS/Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Unit 3 Therapeutics of Microbial diseases No of Hours: 14

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.**
Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.
Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit 4 Prevention of Microbial Diseases No of Hours: 8

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Suggested Readings

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 andAdelberg'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

SECMc 403: Microbial Quality Control in Food and Pharmaceutical Industries
SEMESTER – IV Full Marks: 50
TOTAL HOURS: 40 **CREDITS: 2**

Unit 1 Microbiological Laboratory and Safe Practices **No. of Hours: 6**

Good laboratory practices - Good laboratory practices, Good microbiological practices
Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-
1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples **No. of Hours: 12**

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic
counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion,
sterility testing for pharmaceutical products
Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water **No. of Hours: 12**

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar
Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality
of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards **No. of Hours: 10**

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations
Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking
Water

SUGGESTED READING

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

GEMc-401: CLINICAL IMMUNOLOGY (THEORY)
SEMESTER – IV Full Marks: 75
TOTAL HOURS: 60 CREDITS: (3+1)= 4

Unit 1 host pathogen interaction and effector mechanism No. of Hours: 10
Phagocytosis by macrophages and NK cells ,Activation, development ,maturation and responses of B cells (T dependent and T independent) and Activation, development ,maturation and responses of T cells

Unit2 Immunity to bacterial infection No. of Hours: 12
List of diseases of various organ systems and their causative agents.

Unit 3Immunity to viral infection No. of Hours: 12
List of diseases of various organ systems and their causative agents.

Unit4 Immunity to protozoan infection No. of Hours: 8
List of diseases of various organ systems and their causative agents.

Unit 5 Immunity to fungal infection No. of Hours: 8
Brief description of various types of mycoses.

Unit 6 Immune dysfunction and its consequences No. of Hours: 10
Hyper sensitivity Reactions : Types, mechanism and examples

Autoimmunity : Types, mechanisms and examples

Transplantation immunology : Types, mechanisms and examples

Aids and other immunodeficiencies : mechanisms and examples

GEMc-491: CLINICAL IMMUNOLOGY (PRACTICAL)
SEMESTER –IV **Full Marks: 25**
TOTAL HOURS: 40
CREDITS: 2
(*Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc*.)

1.Activation and responses of B cells and T cells
2.Hyper sensitivity Reactions
3.Autoimmune reactions
4.Transplantation Rejection
5.Aids and secondary immunodeficiencies

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
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edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education
5. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
6. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition Wiley- Blackwell Scientific Publication, Oxford.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

GEMc-402: ENTREPRENEURSHIP DEVELPOMENT (THEORY)
SEMESTER – IV **Full marks 75**
TOTAL HOURS: 60 **CREDITS: (3+1) =4**
UNIT I
Introduction **No. of Hours: 10**

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II

Establishing an enterprise **No. of Hours: 12**

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III

Financing the enterprise **No. of Hours: 15**

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV

Marketing management **No. of Hours: 13**

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V

Entrepreneurship and international business **No. of Hours: 10**

Meaning of International business, Selection of a product, Selection of a market for international Business, Export financing, Institutional support for exports.

Learning Resources

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand &Sons.

GEMc-492: LAB ON ENTREPRENEURSHIP DEVELOPMENT (Practical)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Total Marks-25

Credit: 2

Laboratory period: 40L

1. Assignments- project report on selected products should be prepared and submitted.
2. One day Industry visit

GEMc-403 MOLECULAR DIAGNOSTICS (THEORY)

SEMESTER – IV **Full marks 75**

TOTAL HOURS: 60 **CREDITS: (3+1)= 4**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

UNIT I **No. of Hours: 12**

Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology

UNIT II **No. of Hours: 8**

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology

UNIT III **No. of Hours: 15**

Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests (.Lab – Demonstration of RAPD, Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture)

UNIT IV **No. of Hours: 15**

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT V **No. of Hours: 10**

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting.

GEMc-493: MOLECULAR DIAGNOSTICS (PRACTICAL)

SEMESTER –IV **Full Marks: 25**

TOTAL HOURS: 40
CREDITS: 2

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Applications of enzyme immunoassays in diagnostic microbiology
2. Applications of PCR, RFLP in identification of microorganisms
3. Plasmid finger printing in clinical microbiology
4. Susceptibility tests: Tests for bactericidal activity using antibiotics
5. HPLC

SEMESTER V

CMc-501 RECOMBINANT DNA TECHNOLOGY (THEORY)
SEMESTER –V **Full marks 75**
TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Genetic Engineering No. of Hours: 2
Milestones in genetic engineering and biotechnology

Unit 2 Molecular Cloning- Tools and Strategies No. of Hours: 20
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 3 Methods in Molecular Cloning No. of Hours: 16
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.

Unit4 DNA Amplification and DNA sequencing No. of Hours: 10
PCR: Basics of PCR, RT-PCR, Real-Time PCR
Sanger's method of DNA Sequencing: traditional and automated sequencing
Primer walking and shotgun sequencing

Unit 5 Construction and Screening of Genomic and cDNA libraries No. of Hours: 6
Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Unit 6 Applications of Recombinant DNA Technology No. of Hours: 6
Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH,
antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis

CMc-591: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)
SEMESTER –VI **Full Marks: 25**
TOTAL HOURS: 40
CREDITS: 2
1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

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

CMc-502 INDUSTRIAL MICROBIOLOGY (THEORY)
SEMESTER –V **Full Marks: 75** **TOTAL HOURS: 60**
CREDITS: 4

Unit 1 Introduction to industrial microbiology **No. of Hours: 2**
Brief history and developments in industrial microbiology. Introduction to bioprocess/fermentation technology. Overview of process development and scale up process.

Unit 2 Isolation of industrially important microbial strains and fermentation media **No. of Hours: 10**
Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement. Single cell protein. Principles of upstream processing – Media preparation (Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates) , Inoculum development and sterilization.

Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameters **No. of Hours: 12**
Microbial cell growth in relation to substrate– Batch, Fedbatch and Continuous fermentation. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged).

Components of a typical bio-reactor- Significance of Impeller, Baffles, Sparger . General description of different Types of bioreactors- Laboratory, pilot- scale and production fermenters, Continuous Stirred Tank Bioreactors , Bubble Column Bioreactors AND Cyclone Column

bioreactor , Airlift Bioreactors , Fluidized Bed Bioreactors , Packed Bed Bioreactors and , Photo-Bioreactors.

Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, , foaming , aeration and brief idea on mass transfer coefficient; factors affecting KLa.

Unit 4 Down-stream processing No. of Hours: 6

Product recovery by Solid-liquid separation (filtration, centrifugation) , cell disruption (for release of intracellular products) ,concentration (evaporation, liquid – liquid extraction, precipitation, adsorption), purification(chromatography), formulation(spray drying, lyophilization).

Unit 5 Microbial production of industrial products/metabolites (micro-organisms involved, media, fermentation conditions, downstream processing and uses) No. of Hours: 18

Concept on Primary and secondary metabolites, Microbial production of lactic acid , Citric acid, ethanol, penicillin, streptomycin, tetracyclin, glutamic acid, Vitamin B_{12} ,Kojic acid , acetic acid(vinegar).
Enzymes (amylase, protease, lipase, cellulases, pectinase).
Wine, beer

Unit 6 Enzyme immobilization No. of Hours: 4

Definition, Advantages and applications of immobilized enzymes, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase), Methods of immobilization (adsorption, entrapment, covalent binding, cross linking). Brief idea on biosensors.

CMc-592: INDUSTRIAL MICROBIOLOGY (PRACTICAL)
SEMESTER –V Full Marks: 25
TOTAL HOURS: 40 CREDITS: 2

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
(a) Enzymes: Amylase and Protease
(b) Amino acid: Glutamic acid
(c) Organic acid: Citric acid Lactic acid
(d) Alcohol: Ethanol
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

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.

DSEMc 501A ADVANCES IN MICROBIOLOGY (THEORY)
SEMESTER –V **Full Marks: 50**
TOTAL HOURS: 40
CREDITS: 3

Unit 1 Evolution of Microbial Genomes **No. of Hours: 10**

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 2 Metagenomics **No. of Hours: 10**

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 3 Molecular Basis of Host-Microbe Interactions **No. of Hours: 10**

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,
Biofilms: types of microorganisms, molecular aspects and significance in environment, health care,
virulence and antimicrobial resistance

Unit 4 Systems and Synthetic Biology **No. of Hours: 10**

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial
virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

DSEMc 591A ADVANCES IN MICROBIOLOGY (PRACTICAL)
SEMESTER –V **Full Marks: 50**
TOTAL HOURS: 60 CREDITS: 3

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. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

SUGGESTED READING

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004,
ASM Press
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms,
14th edition, Pearson-Bejamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular
Approach, 3rd edition, ASM Press,
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

DSEMc 501B INSTRUMENTATION AND BIOTECHNIQUES (THEORY)
SEMESTER –V **Full Marks: 50**
TOTAL HOURS: 40
CREDITS:3

Unit 1 Microscopy **No. of Hours: 6**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy,

Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and
Micrometry.

Unit 2 Chromatography **No. of Hours: 6**

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 3 Electrophoresis **No. of Hours:6**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel
electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit 4 Spectrophotometry **No. of Hours: 8**

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV
and visible range. Beer-Lambert law, Colorimetry and turbidometry Factors affecting the absorption properties of a Chromophore.. . Principle of absorption fluorimetry Mass spectrometry(MALDI, ESI) and Introduction to Biosensors and Nanotechnology and their applications. Radioactive labeling & counting, Autoradiography

Unit 5 Centrifugation **No. of Hours: 6**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and Factors affecting Sedimentation, Standard Sedimentation Coefficient,, differential centrifugation, density gradient centrifugation and ultracentrifugation.,Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation. Cell fractionation techniques, isolation of sub-cellular organelles and particles.

Unit 6 X-Ray Crystallography **No. of Hours: 4**

– X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].

Unit 7NMR Spectroscopy **No. of Hours: 4**

– Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, Hyperfine splitting, Relaxation process.

DSEMc 591B INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)
SEMESTER –V Full Marks: 50
TOTAL HOURS: 60 CREDITS: 3

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of λmax for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Understanding density gradient centrifugation with the help of pictures.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
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. 9thEd., 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.

DSEMc 502A MICROBIAL BIOTECHNOLOGY (THEORY)
SEMESTER –V Full Marks: 50
TOTAL HOURS: 60 CREDITS: 3

Unit 1 Microbial Biotechnology and its Applications No. of Hours: 8
Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology
Use of prokaryotic and eukaryotic microorganisms in biotechnological applications
Genetically engineered microbes for industrial application: Bacteria and yeast

Unit 2 Therapeutic and Industrial Biotechnology No. of Hours: 10

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine)
Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics
Microbial biosensors

Unit 3 Applications of Microbes in Biotransformations No. of Hours: 8
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 4 Microbial Products and their Recovery No. of Hours: 6
Microbial product purification: filtration, ion exchange & affinity chromatography techniques
Immobilization methods and their application: Whole cell immobilization

Unit 5 Microbes for Bio-energy and Environment No. of Hours:8
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

DSEMc 592A MICROBIAL BIOTECHNOLOGY (PRACTICAL)
SEMESTER –V Full Marks: 50
TOTAL HOURS: 60 CREDITS: 2

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins

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.

DSEMc 502B PLANT PATHOLOGY (THEORY)
SEMESTER –V Full Marks: 50

TOTAL HOURS: 40 **CREDITS: 3**

Unit 1 Introduction and History of plant pathology **No. of Hours: 4**
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.

Unit 2 Development of a disease **No. of Hours: 2**

Mode of entry of pathogens, Pathogenesis : Prepenetration , penetration and post penetration , dissemination of pathogens . Effect of environment in disease development (temperature, moisture ,wind,light,oxygen and CO_2 concentration, soil pH, host plant nutrition.)

Unit 3 Overview of disease epidemiology **No. of Hours: 4**
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 **No. of Hours: 10**

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.

B. *Genetics of Plant Diseases*
Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant
resistance: true resistance– horizontal & vertical, apparent resistance.

C. *Defense Mechanisms in Plants (only basic concept)*
Concepts on structural defense, biochemical defense, inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins]

Unit 5 Control of Plant Diseases **No. of Hours: 8**

Overview on the General Principles involved in the management of plant diseases by different methods:- Regulatory - quarantine, crop certification, avoidance/evasion of pathogen, use of pathogen free propagative material.
Cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches.
Chemical - protectants and systemic fungicides, antibiotics.
Biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants.
Definition and examples of bioinsecticides ,bionematicides, bioherbicides.

Unit 6 Specific Plant diseases **No. of Hours: 12**

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

A. Important diseases caused by fungi

White rust of crucifers - *Albugo candida*
Late blight of potato - *Phytophthora infestans*
Black stem rust of wheat - *Puccinia graminis tritici*
Loose smut of wheat - *Ustilago nuda*
Red rot of sugarcane - *Colletotrichum falcatum*
Brown spot of rice- *Helminthosporium oryzae*
Blast of rice- *Pyricularis grisea/ Pyricularia oryzae*
Stem rot of jute- *Macrophomina phaseolina*

B. Important diseases caused by phytopathogenic bacteria: Bacterial leaf blight of rice, Citrus canker

C. Important diseases caused by phytoplasmas(Mollicutes): Aster yellow

D. Important diseases caused by viruses: Rice tungro , TMV

DSEMc 592B PLANT PATHOLOGY (PRACTICAL)
TOTAL HOURS: 60 CREDITS: 2 Full Marks: 50

1. Demonstration of Koch's postulates .
2. Isolation and cultivation of plant pathogens from different diseased plant parts. (Through available methods).

SUGGESTED READINGS

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 India Pvt.
Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

SEMESTER VI

CMc-601 VIROLOGY (THEORY)
SEMESTER –VI **Full Marks: 75**
TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Nature and Properties of Viruses **No. of Hours: 12**

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 **No. of Hours**: **10**

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

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication No. of Hours: **20**

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 **No. of Hours: 6**

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

Unit 5 Prevention & control of viral diseases **No. of Hours: 8**

Antiviral compounds and their mode of action
Interferon and their mode of action
General principles of viral vaccination

Unit 6 Applications of Virology **No. of Hours: 4**
Use of viral vectors in cloning and expression, Gene therapy and Phage display

CMc-691 VIROLOGY (PRACTICAL)
SEMESTER –VI **Full Marks: 25**
TOTAL HOURS: 40 CREDITS: 2
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 and enumeration of bacteriophages (PFU) from water/sewage sample using double agar
layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

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.

CMc-602 Genomics Proteomics and Bioinformatics
SEMESTER –VI
TOTAL HOURS: 60 **CREDITS: 4**

Unit 1. Introduction to Genomics: **No. of Hours**: **7**

Information flow in biology, DNA sequencing methods– manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit 2. **Managing and Distributing Genome Data: No. of Hours**: **5**

Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome, GenBank, EMBL. Concept of INSDC, Selected Model Organisms' Genomes and Databases.

Unit 3: Single Nucleotide Polymorphisms: No. of Hours: **5**

Genome variation; Single nucleotide polymorphism idea of Missense,Synonymous, Frameshift SNPs, SNP profiling, Disease and SNPs. Basic idea of DNA microarray and SNP array.

Unit 4: Structure and properties of proteins No. of Hours: **5**

Introduction to protein structure, Chemical properties of proteins, Physical interactions that determine the property of proteins. Determination of sizes (Sedimentation analysis, gel filtration, Native PAGE, SDS-PAGE); Determination of covalent structures of proteins

Unit 5: Introduction to Proteomics No. of Hours: **5**

Fundamental goals of proteomics, Analysis of proteomes. 2D-PAGE (Sample preparation,solubilization, reduction, resolution. Reproducibility of 2D-PAGE). Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

Unit 6: Protein databases and networks: No. of Hours: **10**

protein sequence and structural data, protein information resources and secondary data bases, protein data bank. Introduction to preliminary analysis of the transcriptome, Proteomics-Expression analysis & Characterization of proteins, Protein microarray, Metabolomics & global biochemical networks.

Unit 7: Introduction to Bioinformatics No. of Hours: **5**

History of Bioinformatics. Importance of Bioinformatics in the field of biology and healthcare, Goal and Scope of bioinformatics. Central Dogma and bioinformatics.

Unit 8: Data Generation and Data Retrieval **No. of Hours**: **4**
Sequence submission tools (BankIt, Sequin); Sequence filenformat (flat file, FASTA, Genbank, Genpept, EMBL, Swiss-Prot); D ata retrieval systems (NCBI Entrez).

Unit 9: Sequence Alignment and Pattern recognition **No. of Hours 14**
Sequence similarity searching; Methods of Alignment (Dot matrix,Dynamic Programming, BLAST and FASTA algorithm); Local and global alignment, pairwise and multiple sequence alignments (without algorithm); Concept of identity and homology of sequences. Scoring Matrices (PAM, BLOSUM).

CMc-692 Genomics Proteomics and Bioinformatics (PRACTICAL)
SEMESTER –VI
TOTAL HOURS: 40 **CREDITS: 3**

1. **Internet basics in hand (I**ntroduction to computer hardware and software, Concept of intranet and internet. LAN, MAN and WAN, IP address, MAC address. Internet Browsers and search engine.)
2. **Introduction to NCBI**
   Database Handling of NCBI; PubMed, Nucleotide, Protein, Gene, SNP, EST, OMIM.
   Tools of NCBI;Genome Browser, performing various kinds of blast.
3. **Multiple Sequence alignment tool;** Clustal W2
4. USING PIR,
5. **Handling Structural data;** PDB
   Visualization of structures; using Rasmol
   .

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition.Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
4. David W Mount Bioinformatics: Sequence and Genome analysis Cold Spring Harbor Laboratory Press.
5. Fundamentals of Biochemistry by Voet, Voet and Pratt.

DSEMc 601A MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)
SEMESTER –VI **Full Marks: 50**
TOTAL HOURS: 40
CREDITS: 3

Unit 1 Soil Microbiology **No of Hours: 5**

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

Unit 2 Mineralization of Organic & Inorganic Matter in Soil No of Hours: 5
Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate,
silica, potassium

Unit 3 Microbial Activity in Soil and Green House Gases No of Hours: 5
Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 4 Microbial Control of Soil Borne Plant Pathogens No of Hours: 5
Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant
pathogens, Insects, Weeds

Unit 5 Biofertilization, Phytostimulation, Bioinsecticides No of Hours: 8
Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*),
Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae),
Novel combination of microbes as biofertilizers, PGPRs

Unit 6 Secondary Agriculture Biotechnology No of Hours: 8
Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Unit 7 GM crops No of Hours: 4
Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

DSEMc 691A : MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT
(PRACTICAL)
SEMESTER –VI Full Marks: 50
TOTAL HOURS: 40
CREDITS: 3
1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter* as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant

6. Isolation of cellulose degrading organisms

SUGGESTED READINGS

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

DSEMc 601B BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)
SEMESTER –VI **Full Marks: 50**
TOTAL HOURS: 40
CREDITS: 3

Unit 1 No of Hours: 4
Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types;
Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

Unit 2 No of Hours: 8
Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM,
GEAC etc. 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 3 No of Hours: 4
AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

Unit 4 No of Hours: 8
Introduction to Intellectual Property: 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 No of Hours:8
Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional,
Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and
agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent
owner.

Unit 6 No of Hours: 8
Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement;
WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent
Amendments
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DSEMc 691B BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (PRACTICAL)
SEMESTER –VI **Full Marks: 50**
TOTAL HOURS: 40 CREDITS: 3
1. Study of components and design of a BSL-III laboratory
2. Filing applications for approval from biosafety committee
3. Filing primary applications for patents
4. Study of steps of a patenting process
5. A case study

Suggested Reading
1. Bare Act, 2007.Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.

4. Singh K K (2015). Biotechnology and Intelectual Property Rights: Legal and Social Impliocations, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics. Pearson
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and

DSE Mc-602 Project/ Dissertation **Full marks -100**
Laboratory Work: 60 hrs **Credit 6**

A project work should be done individually under the guidance of one faculty member on any topic related to the subject & can be recorded as dissertation & also be presented by the candidate in front of externals in a seminar.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

BACHELOR OF SCIENCE IN MICROBIOLOGY

Curriculum Structure

(Applicable from the academic session 2018-2019)

MOOCS BUSKET

Sl. No.	Course	Course Provider	Course Duration	Credits
1	Speaking Effectively	NPTEL	8 wks	3
2.	Intellectual Property	NPTEL	12 wks	4
3.	Ethics	NPTEL	12 wks	4
4	Biostatistics and Design of experiments	NPTEL	8wks	3
5	Human molecular Genetics	NPTEL	4Wks	1
6.	Functional genomics	NPTEL	4wks	1
7.	Research writing	NPTEL	4wks	1
8.	Introductory mathematical methods in biologists	NPTL	8wks	3
9.	Wild life conservation	NPTL	4wks	1
10.	Biomedical nanotechnology	NPTL	4 wks	1
11.	Industrial biotechnology	NPTL	12wks	4
12.	Bioreactors	NPTEL	4 wks	1