

UNIVERSITY OF DHAKA



**Syllabus of the
Department of Microbiology**

for

BS Honours Course

for the

Sessions: 2015-2016 to 2016-2017 and onward

**THE UNIVERSITY OF DHAKA
BANGLADESH**

**UNIVERSITY OF DHAKA
DEPARTMENT OF MICROBIOLOGY**

Syllabus for 4 year BS (Honours) Course

Sessions: 2015-2016 to 2016-17 and onward

To be eligible for admission into the 4-year BS (Honours) courses in Microbiology, the candidates must have Biology, Chemistry and Physics including Mathematics in their HSC or equivalent examination in Science group or in recognized equivalent examination. The educational qualification of the candidates shall be decided as per University admission rules. The 4-year (Honours) will span over 128 credits of which year-wise course distribution has been detailed below. Of these 128 credits, 16 credit shall have to be taken as extra-departmental courses. These 16 credits will be distributed in the First Year and Second Year courses. Total credit points of extra-departmental courses will be added to the major Honours subjects for deciding grades. During the fourth year, practical courses and research projects/ internship will be assigned to the students.

The Credit distribution in 4-year Honours course is as follows:

First year	Departmental Course	18 Credit
	Extra-Departmental Course	8 Credit
Second Year		
	Departmental Course	22 Credit
	Extra-Departmental Course	8 Credit
Third year	Departmental Course	34 Credit
Fourth year	Departmental Course	38 Credit
Total		128 Credit

Course Outline of the Four-Year BS (Honours)

First Year BS (Honours)

Course No.	Course Name	Credit
Departmental Courses		
	MBG 101: Fundamental Microbiology	2
	MBG 102: Microbial Ecology	2
	MBG 103: Human Physiology	2
	MBG 104: Basic Techniques in Microbiology	2
	MBG 105: Computer Fundamentals	2
	MBG 106: Fundamental Course in English	2
	MBG 107: Practical	4
	MBG 108: Viva Voce	2
Extra-Departmental Courses		
	MBG 109: Basic Biochemistry	4
	CM 100F: Fundamentals of Chemistry	4
Total		26 Credit

Second Year BS (Honours)

Course No.	Course Name	Credit
Departmental Courses		
	MBG 201: General Microbiology	2
	MBG 202: Environmental Microbiology	2
	MBG 203: Microbial Physiology and Metabolism-I	2
	MBG 204: Basic Microbial Genetics	2
	MBG 205: Medical Microbiology- I	2
	MBG 206: Fundamental Cell Biology	2
	MBG 207: Microbiology of Food and Frozen Food	2
	MBG 208: Applied Mycology	2
	MBG 209: Practical	4
	MBG 210: Viva Voce	2
Extra-Departmental Courses		
	MBG 211: Biostatistics and Calculus	4
	CM 222H: Biologically Important Organic Compounds	2
	CMGL 101H : General Chemistry Laboratory	2
Total		30 Credit

Third Year BS (Honours)

Course No.	Course Name	Credit
Departmental Courses		
	MBG 301: Virology-I	2
	MBG 302: Microbial Physiology and Metabolism-II	2
	MBG 303: Microbial Molecular Genetics	2
	MBG 304: Medical Microbiology-II	2
	MBG 305: Immunology-I	4
	MBG 306: Agriculture Microbiology	2
	MBG 307: Molecular Cell Biology	2
	MBG 308: Fermentation Technology	2
	MBG 309: Enzymology	2
	MBG 310: Pharmaceutical Microbiology	2
	MBG 311: Advanced Food Microbiology	2
	MBG 312: Practical	8
	MBG 313: Viva-Voce	2
Total		34 Credit

Fourth Year BS (Honours)

Course No.	Course Name	Credit
Departmental Courses		
	MBG 401: Virology-II	4
	MBG 402: Immunology-II	2
	MBG 403: Environmental Pollution and Bioremediation	2
	MBG 404: Genomics and Bioinformatics	2
	MBG 405: Genetic Engineering	2
	MBG 406: Industrial Microbiology	2
	MBG 407: Microbial Biotechnology	4
	MBG 408: Diagnostic Microbiology	2
	MBG 409: Analytical Techniques in Life Sciences	4
	MBG 410: Quality Control of Food and Pharmaceuticals	2
	MBG 411: Public Health and Epidemiology	2
	MBG 412: Practical/Research Project/Internship	8
	MBG 413: Viva-Voce	2
Total		38 Credit

Courses for the First Year BS (Honours)

MBG 101: Fundamental Microbiology

(2 Credit)

1. **Development of Microbiology:** discovery of microorganisms; biogenesis *versus* abiogenesis; fermentation process; germ theory of disease; Koch's postulate; development of laboratory techniques, vaccination; antisepsis; chemotherapy
2. **Scope of Microbiology:** in human welfare, agriculture, industry, health and sanitation; environment and pollution control
3. **Prokaryotic Cells:** morphological characterization, ultra structure and chemical composition of prokaryotic cells; functions of different sub cellular elements; endosymbiotic hypothesis
4. **Bacteria:** size, shape and arrangements; characteristics of Gram-negative and Gram positive bacteria morphological characteristics; nutritional and cultural characteristics;
5. **Microorganisms other than bacteria (Archaea, Viruses, Fungi, Algae, Protozoa):** general characteristics; morphological and physiological properties, classification, economic importance

Books Recommended

1. Brock Biology of Microorganisms (International Edition) / By Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark – Pearson Prentice Hall, 2012 (12th Ed.)
2. Microbiology / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
3. Microbiology: Concepts and Applications / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
4. Microbiology: An Introduction / By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)
5. Fundamental Principles of Bacteriology / By AJ Salle – McGraw Hill Book Company Inc., New York, 1948
6. General Microbiology / By Hans G. Schlegel, C. Zaborosch and M. Kogut – Cambridge University Press, 1993

MBG 102: Microbial Ecology

(2 Credit)

1. **Basic Concept of Microbial Ecology:** the scope of microbial ecology; historical overview; relation of microbial ecology to general ecology
2. **Microbial Communities and Ecosystems:** development of microbial communities; structure of microbial communities; ecosystems; microbial communities in nature
3. **Brief Introduction to Microorganisms in Natural Habitats:** atmosphere: characteristics and stratification of the atmosphere, the atmosphere as habitat and medium for microbial dispersal, microorganisms in the atmosphere; hydrosphere ecology of fresh water, composition and activity of fresh water microbial communities; physical and chemical factors, estuaries and marine water environment; characteristics and stratification of the ocean; composition and activity of marine microbial communities; role of microbes in the aquatic environment and lithosphere; introduction to soil formation: rocks and mineral, soil horizon, soil texture, soil organic matter, chemical properties of soil, soil microbial communities.
4. **Effect of Abiotic Factors on Microorganisms:** abiotic limitations to microbial growth; Leibig's law of minimum; Shelford's law of tolerance; temperature, radiation, pressure, salinity, water activity, movement, hydrogen ion concentration, redox potential, organic compounds and inorganic compounds
5. **Adaptation and Interactions of Microorganisms in the Extreme Environments:** hot springs, acid springs and lakes, salt lakes, Antarctica, extraterrestrial systems

Books Recommended

1. Microbial Ecology: Fundamentals and Applications / By Ronald M. Atlas; Richard Bartha – Addison Wesley Longman, New York, 1998 (4th Ed.)
2. Microbial Ecology: A Conceptual Approach / Edited by J. M. Lynch and N. J. Poole – John Wiley & Sons, New York, 1979
3. Microbiology / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book

- Company, 1986 (5th Ed.)
4. Microbiology: Concepts and Applications / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
 5. Microbiology: An Introduction / By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)

MBG 103: Human Physiology

(2 Credit)

1. **Digestion and Digestive System:** mechanisms and control of the secretion; composition of digestive juices; digestion and absorption of foodstuffs
2. **Blood and Circulatory System:** composition, formation, destruction and function of blood; blood coagulation; blood groups; tissue fluid; cardiovascular system
3. **Respiratory System and Respiratory Stimulants:** structures and functions of lungs, liver, kidney, pancreas, spleen and nervous system
4. **Water and electrolytic balance**
5. **Lymphoid and lymphatic system**
6. **Endocrinology:** functions, mechanisms and properties of different hormones.
7. **Reproductive System:** structure and function of testis, ovary, uterus and placenta

Books Recommended

1. Introduction to Human Physiology / By Mary Griffiths – Macmillan, New York, 1981
2. Human Physiology / By Robert F. Schmidt, Gerhard Thews- Springer Verlag, 1989
3. Human Anatomy, Physiology and Pathophysiology / By Gerhard Thews, Ernst Mutschler and Peter Vaupel – Elsevier , New York, 1985

MBG 104: Basic Techniques in Microbiology

(2 Credit)

1. **Microscopes and Microscopy:** light spectrum, resolving power and magnification power; microscopes: light and electron microscopes; microscopy: bright-field, dark-field, fluorescence, phase-contrast, differential interference contrast, transmission electron, scanning, scanning tunnelling and atomic force microscopy
2. **Observation of Microorganisms under Microscope:** wet-mount and hanging-drop technique; preparation of microorganisms for staining; chemical properties of stains; mechanisms of staining; positive and negative staining; simple, differential and special staining techniques
3. **Cultivation of Microorganisms:** Nutritional Requirements for Microbial Growth: chemical elements as nutrients; organic growth factors; nutritional classification of microorganisms; criteria for an ideal culture medium; media used for cultivation microorganisms: chemically defined media, complex media, anaerobic growth media, selective and differential media; enriched culture; anaerobic culture method; pure culture techniques, special purpose media for eukaryotic microorganisms;
4. **Culture Preservation:** long-term and short-term techniques for preservation of microbial culture
5. **Measurement of Growth:** direct measurement of microbial growth; estimating bacterial number by indirect methods

Books Recommended

1. Brock Biology of Microorganisms (International Edition) / By Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark – Pearson Prentice Hall, 2012 (12th Ed.)
2. Microbiology / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
3. Microbiology: Concepts and Applications / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
4. Microbiology: An Introduction / By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)
5. Fundamental Principles of Bacteriology / By AJ Salle – McGraw Hill Book Company Inc., New York, 1948
6. General Microbiology / By Hans G. Schlegel, C. Zaborosch and M. Kogut – Cambridge University Press, 1993

MBG 105: Computer Fundamentals**(2 Credit)**

1. **Introduction:** Basic organization, types, brief history, and computer generations.
2. **Number systems and codes:** Binary, decimal, octal and hexadecimal number system, binary number system and digital electronics, data representation and codes; numeric data representation, BCD code, alpha-numeric code, Unicode, ASCII code.
3. **Digital circuit:** Logic gates, primary logic gates, secondary logic gates, logic functions, Boolean theorem, De-Morgans theorem, logic simplification, Karnaugh maps, design of combinational digital circuits, binary adder, latches.
4. **Microcomputer system:** Basic microcomputer system, microprocessor organization, machine cycle, computer memory; memory types, primary and secondary memory, latches, flipflops, registers, flash memories, BUS organization; input and output devices
5. **Operating system and computer software:** System software and operating system, Software development and programming languages, algorithms, compilation and interpretation, program development cycle, database and basic database concepts,
6. **Basic applications:** Applications of MS word, MS excel, MS access, SPSS, bioinformatics tools and databases; GenBank, PDB, Swissprot, Bioedit, MEGA, Chromas, clustal W.

Books Recommended:

1. Computer Fundamentals / By Rahman, M. Lutfar; Hossain, M. Alamgir. – Systech, Dhaka 2011
2. Introduction to Computer Science/By Murrill P. W.; Smith C. L. – Harper and Row, New York 1973
3. Computer Fundamentals: Concepts, Systems and Applications / By Pradeep K. Sinha and Priti Sinha – BPB Publications, New Delhi, 2016 (6th Ed.)
4. Computer fundamentals / By Anita Goel – Pearson New Delhi 2014
5. Fundamentals of computer / By Akash Saxena, Sunil Chauhan and Kratika Gupta – Laxmi Publications, 2008

MBG 106: Fundamental Course in English**(2 Credit)**

1. **Reading:** Strategies of Reading: Predicting, Skimming, scanning, inferencing and analyzing selected texts: variety of texts reflecting common interests; special texts related to students' major courses.
2. **Writing:**
 - Writing process: brainstorming, outlining, drafting, editing and proofreading
 - Paragraph development: Paragraph structure, types of paragraphs including descriptive and narrative, cause and effects, argumentative paragraphs.
 - Essay writing: Essay structure and types, thesis statement, introduction and conclusion.
 - Report writing: Academic reports, lab reports, summary/paraphrase writing
 - Writing research papers: planning a research paper, method, organizing extracted information, drafting, and revising, ethical issue of writing.
3. **Grammar:**
 - Prepositions used with adjectives, participles, verbs, gerunds and adverbs.
 - Verbs: classes of verbs, auxiliary verbs (be, have, do, may, can, should etc.), agreement of the verb with the subject.
 - Tense: present, past and perfect tense and the future tense.
 - The Gerund: forms and uses
4. **Speaking:**
 - Introducing self and others
 - Expressing like and dislikes, personal experiences, apologies and excuses, comparison and contrast
 - Describing people/place/events, saying times
 - Giving and following instruction, reporting, complaining
 - Seminar presentation and interviews.
5. **Listening:** Listening comprehensions focusing on varying elements of vocabulary and structures will be practiced. Student will be taught how to be an active listener to obtain information and key ideas.

Books Recommended

1. Ramage JD, Bean JC, Johnson J. Allyn and Beacon Guide to Writing. Longman (5th edition 2008 or later edition).
2. Beaumont D, Granger C. The Heinmann ELT English Grammar. Macmillan (1995 or later edition).
3. Smithies M. Advanced English Comprehensive Texts for Science Students. Collier- Macmillan (1973 or later edition).

MBG 107: Practical

(4 credit)

Introduction to safety regulations and hygiene practice on working in Microbiology Laboratory.

Part A (Microscopy)

1. Use and function of microscopes
2. Observation of stained cell preparations
3. Observation of living bacterial cells
4. Observation of living yeasts and molds
5. Micrometry: measurement of microbial cell

Part B (Bacterial Staining)

1. Simple staining and negative staining
2. Gram staining
3. Acid-fast staining
4. Capsule staining
5. Spore staining
6. Flagella staining

Part C (Human Physiology)

1. Circulatory system: total blood cell count; differential count for WBC; determination of serum bilirubin, cholesterol and non-esterified fatty acid, uric acid, glucose, etc. in blood
2. Gastro-enteric system
3. Genito-urinary tract system
4. Respiratory tract system

Part D (Cultivation Techniques)

1. Media preparation and sterilization techniques
2. Culture transfer techniques
3. Techniques for isolation of pure cultures
4. Techniques for preservation and maintenance of pure cultures
5. Observation of cultural characteristics of bacteria on various media
6. Observation of cultural characteristics of yeast on various media

Part E (Computer Fundamentals)

1. Microsoft office (MS word S excels, MS PowerPoint)
2. Introduction to referencing software (eg. EndNote, Zotero)
3. Introduction to sequence database, protein database
4. Computational Language for Expressing Computation

Part F (Determination of Biomolecules)

1. Preparation of different lab solutions (molar, molal, normal solutions and buffers)
2. Determination of citric acid by titrimetric method
3. Determination of antibiotic agents
4. Estimation of protein
5. Determinations reducing sugar
6. Detection of cytoplasmic inclusions (PHB and volutin)

MBG 108: Viva Voce

(2 Credit)

Extra-Departmental Minor Courses for Department of Microbiology

MBG 109: Basic Biochemistry

(4 Credit)

1. **Acid, Base and Buffer:** Ion product of water; acid; base; pH; pH indicator buffer solution and buffer capacity
2. **Thermodynamics:** 1st law of thermodynamics; enthalpy; Hess's law; 2nd law of thermodynamics; entropy; free energy; standard states; spontaneous reversible, irreversible and non-equilibrium reactions; steady state
3. **Cell:** cell, sub-cellular particle and their function
4. **Carbohydrates:** nomenclature; functions; optical properties; general reactions; colour tests and method of estimation; selection from natural sources and representative examples of each class with note on characteristics
5. **Lipids:** nomenclature; classification; reactions of fatty acids; sterols and methods of estimation; structure and biological functions of different classes of lipids
6. **Amino Acids and Peptides:** structural features optical activity and classification of amino acids ionization of solution; behaviour; colour tests; isolation of amino acids from protein hydrolysates; peptide bonds and biologically important peptides
7. **Proteins:** general introduction; classification based on shape, structure and biological properties; isolation from natural sources; different levels of structural organization (in brief); enzymes chemical nature; K_m value and V_{max} ; enzyme inhibition; digestive enzymes
8. **Nucleosides and Nucleotides:** basic chemistry of nucleosides and nucleotides; polynucleotides
9. **Vitamins:** classification; occurrence; deficiency symptoms; biological functions; vitamins as coenzymes
10. **Laboratory Works:**
 - a) Preparation of standard solution and standardization of HCl
 - b) Determination of calcium in biological sample
 - c) Determination of ascorbic acid component of biological sample
 - d) Colour test for biomolecules
 - e) Determination of lactose contents of milk
 - f) Determination of inorganic phosphorus content of the supplied solution

Extra-Departmental Minor Courses Offered by the Department of Chemistry

CM 100F: Fundamentals of Chemistry

(4 Credit)

1. **The Structure of Atoms:** the discovery of electron proton and neutron; cathode rays; radioactivity;
□-particles; scattering Rutherford model; fraction of atomic masses; isotopes; mass spectroscopy spectrum of atomic hydrogen; Bohre models; dual nature of matter; wave nature of electrons; atomic orbital; electron configuration of atom
2. **Radioactivity and Nuclear Reactions:** nuclear binding energy: fission and fusion reactions
3. **Periodic Classification of Elements:** ionization potential; electro negativity; electron affinity; atomic radius; variation of properties along a period and a group; diagonal relationship; representative elements; transition elements; chemical properties of s-, p- and d-block elements
4. **Chemical Bonds:** electronic theory; valence bonds theory; molecular orbital theory; sigma (δ)- and pi (π) bonds; C-C bonds; catenation; polar molecules electro negativity and electron affinity; hydrogen bond; shapes of molecules; VSEPR theory; hybridization
5. **Oxidation and Reduction:** oxidation number; analytical reagents
6. **States of Aggregation of Matter:** kinetic theory of matter; nature of heat; changes of states
7. **The Gaseous State:** the gas laws; the perfect gas equation; the kinetic theory of gases; the distribution of molecular velocities; inter molecular attraction; liquefaction of gases; the critical state; the critical constants

8. **Vapour Pressure of Liquids:** temperature dependent mixtures of liquids; Raoult's law; fractional distillation; solutions of non-volatile solids; colligative properties of solutions; Henry's law; Nernst distribution law
9. **Energy Changes in Chemical Reactions:** the first law of thermodynamics F; the concept of internal energy and enthalpy; measurement of enthalpy changes; enthalpy of formation; Hess's law; lattice enthalpy; Born-Haber cycle; spontaneous process; concept of entropy
10. **Chemical Equilibrium:** the equilibrium law; the equilibrium constant; homogeneous and heterogeneous equilibrium; the principal of Le Chatelier and Brown; the dependence of K on temperature
11. **Acids and Bases:** the Lewis concept; the Bronsted concepts in strong and weak acids; acid-base equilibrium in aqueous solutions; Ostwald dilution law; pH; buffer solutions; neutralisation curves; indicators for acid-base titration
12. **Electrolysis:** galvanic cells; electrodes and electrode reactions reduction potential; the electrochemical series the standard hydrogen electrode; measurement of pH
13. **Rates of Chemical Reactions:** order and molecularity; zero and first order reactions; half life; carbon dating; temperature dependence of rates of reaction
14. **The Organic Compounds and Organic Chemistry:** hydrocarbons; aliphatic hydrocarbons; standard and unsaturated hydrocarbon; alkanes, alkenes and alkynes; the aromatic hydrocarbons; delocalisation in the benzene ring; nomenclature of organic compounds; the IUPAC system; petroleum; natural gas; refining of petroleum; petrochemicals
15. **The Concept of Acid Bases, Nucleophiles, Electrophiles, Carbocations and Carboanions and Free Radicals**
16. **Reactions of Alkanes, Alkenes and Alkynes:** substitution and hydrogen **abstraction** reactions in alkanes; hydrogenation; hydrohalogenation; ozonolysis of alkenes and alkynes; homolytic addition of hydrogen halides; geometrical isomers
17. **Functional groups:** alcohols, aldehydes, ketones, ethers, epoxides, amines, amides; typical reactions of the functional groups
18. **Some Important Reactions of the Aromatic Compounds:** substitution at the benzene ring; Friedel-Craft's reaction; diazotization and coupling; sulphonation and nitration
19. **Organic Macro Molecules:** polythene; teflon; plastic; resin; nylon; peptides; proteins; cellulose and starch

Books Recommended

1. General chemistry / By Darrell D. Ebbing; Mark S. Wrighton – A.I.T.B.S publishers, Delhi, 2005
2. Chemistry – Coxon JM, Gergusson JE & Philips IF
3. A-Level Chemistry – Ramsden EN

Courses for the Second Year BS (Honours)

MBG 201: General Microbiology

(2 Credit)

1. **Metabolic activities of microorganisms:** Starch, lipid, casein and gelatine hydrolysis tests, Carbohydrate (LDS) fermentation, MIU, KIA and IMViC tests, Nitrate reduction, oxidise, catalase and litmus milk reaction tests.
2. **Growth of Bacteria:** bacterial multiplication; generation time; mathematical expression of growth; phases of growth; synchronous growth; batch, fed-batch and continuous culture
3. **Control of Microbial Growth:** principles of microbial control; the rate of microbial death; the action of microbial control agents; conditions influencing microbial control; physical and chemical methods of control.
4. **Antimicrobial Agents:** type, chemistry, mode of action and efficiency. Study of penicillin, tetracycline, chloramphenicol, nystatin, gentamicin and griseofulvin.
5. **Atypical Bacteria:** general characteristics and importance of actinomyces, cyanobacteria, mycoplasmas, rickettsias, chlamydias and spirochetes; gliding, sheathed, budding and appendaged bacteria

Books Recommended

1. Principles of Microbiology / By Ronald M. Atlas – William C Brown Pub, 1996 (2nd Ed.)
2. Microbiology / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
3. Microbiology: Concepts and Applications / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
4. Microbiology: An Introduction / By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)

MBG 202: Environmental Microbiology (2 Credit)

1. **Biological Interactions:** microbial interaction: interaction within a single microbial population, positive and negative interactions, interaction between diverse microbial populations; neutralism, commensalism, synergism, mutualism, competition, ammensalism, parasitism, predation; microbe plant interaction and microbe animal interaction.
2. **Techniques for Studying Environmental Microbes:** sample collection; sample processing; detection of microbial populations; determination of microbial numbers; determination of microbial biomass; measurement of microbial metabolism.
3. **Microbiology of Potable Water:** introduction to indicator organisms; water-borne pathogens; isolation and identification of indicator bacteria; water-borne pathogens.
4. **Sanitation and Public Health Microbiology with Special Reference to Bangladesh:** water supply; the use of safe water; public tube well coverage.
5. **Microorganisms and Some Novel Pollution Problem:** persistence and biomagnification of xenobiotic molecules; recalcitrant halocarbons, polychlorinated biphenyls (PCBS), alkyl benzyl sulfonates and synthetic polymer
6. **Sewage Treatment:** primary treatment; secondary treatment; aerobic and anaerobic treatment; tertiary treatment

Books Recommended

1. Microbial Ecology: Fundamentals and Applications / By Ronald M. Atlas; Richard Bartha – Addison Wesley Longman, New York, 1998 (4th Ed.)
2. Microbial Ecology: A Conceptual Approach / Edited by J. M. Lynch and N. J. Poole – John Wiley & Sons, New York, 1979
3. Microbiology / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
4. Microbiology: Concepts and Applications / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
5. Microbiology: An Introduction / By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)
6. Microbial Ecology: Organism, Habitats, Activities / By Heinz Stolp – Cambridge University Press, Cambridge 1988

MBG 203: Microbial Physiology and Metabolism-I (2 Credit)

1. **Introduction to Metabolism:** important differences and relationships between anabolic and catabolic mechanisms in life
2. **Cell Bioenergetics:** Membrane bioenergetics: the Chemiosmotic Theory; electrochemical energy, use of the $\Delta\mu$, exergonic reactions that generate a $\Delta\mu$. Bioenergetics in the Cytosol: high-energy molecules and group transfer potential, the central role of group transfer reactions in biosynthesis, ATP generation by different processes; free energy; energy coupling.
3. **Electron Transport:** Aerobic and Anaerobic Respiration, The Electron Carriers, Organization of the Electron Carriers in Mitochondria, Organization of the Electron Carriers in Bacteria, Coupling Sites, Proton Pumps, Patterns of Electron Flow in Bacteria.
4. **Solute Transport:** kinetics of solute uptake, energy-dependent transport, source of energy for transport.
5. **Central Metabolic Pathways:** Glycolysis, the fate of NADH, the pentose phosphate pathway, the Entner–Doudoroff pathway, TCA cycle. Carboxylations that replenish oxaloacetate. The pyruvate and phosphoenolpyruvate carboxylases glyoxylate cycle, glyoxal bypass; inter linkages of pathways; anapleuretic reactions, pathways for utilisation of sugars other than glucose.

6. **Fermentations:** Oxygen Toxicity, Energy Conservation by Anaerobic Bacteria, Propionate Fermentation: Acrylate Pathway, Succinate–Propionate Pathway, Acetate Fermentation, (Acetogenesis), Lactate Fermentation, Mixed-Acid and Butanediol Fermentation, Butyrate Fermentation
7. **Catabolic Activities of Aerobic Heterotrophs:** growth with organic acids (beta-oxidation), amino acids, aromatic compounds, aliphatic hydrocarbons and Cl compounds.

Books Recommended

1. The Physiology and Biochemistry of Prokaryotes / By David White, James Drummond and Clay fuqu – Oxford University Press, 2011 (4th Ed.)
2. Microbial Physiology / By Albert G. Moat and John W. Foster – John Wiley, New York ; Chichester 1995 (3rd Edition)
3. Bacterial Metabolism / By Gerhard Gottschalk – Springer-Verlag, New York 1979 (2nd Ed.)
4. Microbiology/By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
5. Microbiology: Concepts and Applications / By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
6. Lehninger Principles of Biochemistry / By David L. Nelson and Michael M. Cox – W.H. Freeman and Company, New York 2013 (6th Ed.)

MBG 204: Basic Microbial Genetics (2 Credit)

1. **Mendelism:** Mendel's experiments and his interpretation; the basic principles of dominance, segregation and independent assortment; misinterpretations of Mendelian principles
2. **Chromosomal Basis of Inheritance:** the chromosome theory of heredity; sex chromosomes and sex determination; sex-linked genes in human beings; variation in chromosome number and structure
3. **Replication of DNA:** Semi-conservative replication; experiments of Meselson and Stahl; DNA polymerases; proof-reading activities of DNA polymerases; the mechanism of DNA replication; circular DNA replication.
4. **Transcription in Prokaryotes and Eukaryotes:** different types of RNA molecules; prokaryotic and eukaryotic RNA polymerases; mechanism of transcription in prokaryotes and eukaryotes; post-transcription modification of RNA; interrupted genes in eukaryotes; mechanism of removal of intron sequences
5. **Translation and the Genetic Code:** polypeptides and proteins; synthesis of polypeptide chain; nonsense mutation and suppressor mutation; the genetic code; Wobble hypothesis; post-translation modification of protein.

Books Recommended

1. Genetics / By Monroe W. Strickberger – Prentice Hall College Div; 1985 (3rd Ed.)
2. Genetics / By D. Peter Snustad and Michael J. Simmons – John Wiley & Sons, Inc., 2012 (6th Ed.)
3. Genetics: Analysis of Genes and Genomes / By Daniel L. Hartl and Maryellen Ruvolo – Jones & Bartlett, New Delhi, 2012 (1st Ed.)
4. Molecular Biology of the Gene / By James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick – Pearson, San Francisco 2013 (7th Ed.)
5. Molecular Biology / By David Freifelder – Jones and Bartlett, Boston 1983
6. Essential Genetics / By Peter J Russell – Blackwell Science Inc; 1987 (2nd Ed.)
7. Principles of Genetics / By Eldon John Gardner, Michael J. Simmons and D. Peter Snustad – John Wiley and Sons, New York 1991 (8th Edition)

MBG 205: Medical Microbiology-I (2 Credit)

1. **Infection and Infectious Diseases:** concept of infection and infectious diseases; pathogenesis of infectious diseases; virulence (ID₅₀, and LD₅₀)
2. **Major Reservoirs of Microbial Pathogens and transmission of disease:** acquisition of and mode of transmission of diseases. Brief to nosocomial infection.

3. **Brief Introduction to Virulence factors:** adherence factors; invasion of host cells and tissues; toxins; enzymes; intracellular pathogenesis; antigenic heterogeneity; iron acquisition
4. **Host-Microbe Interaction:** normal resident microflora of human body and their role; initial colonization of a new born; introduction to resident flora of skin, mouth, upper respiratory tract, intestinal tract, uro-genital tract, eye
5. **Non-Specific Host Defences against Microbial Pathogens:** primary defenses conferred by tissues and blood
6. **Progress of an Infection:** true and opportunistic pathogens; portal of entry; size of inoculum; stages in the course of infections and diseases; mechanism of invasion and establishment of the pathogens; signs and symptoms of a disease; portal of exit
7. **Brief Introduction to the Microbiology of Major Infectious Diseases:** Skins, respiratory system; nervous system; genito-urinary tract; gastrointestinal tract; circulatory system
8. **Brief introduction to clinically important parasites:** *Giardia*; *Entamoeba*, *Leishmania*, *Taenia*

Books Recommended:

1. Jawetz, Melnick and Adelberg's Medical Microbiology / Edited by Karen C. Carroll, Stephen A. Morse, Timothy Mietzner, Steve Miller – McGraw Hill Education, 2016 (27th Ed.)
2. Essential Clinical Microbiology: an introductory text / By E. M Cooke and G. L. Gibson – Wiley and Sons, New York, 1984
3. Bacterial Pathogenesis: A Molecular Approach / By Abigail A. Salyers and Dixie D. Whitt – ASM Press, 2002 (2nd Ed.)
4. Medical Microbiology / By Duguld JP, Marinian BP and Swain RHA
5. Medical Microbiology / By Mims C, Playfair J, Roitt I, Wakelin D and Williams R.

MBG 206: Fundamental Cell Biology

(2 Credit)

1. Prokaryotic cells and eukaryotic cells and their molecular architecture.
2. Membrane transport in eukaryotic cells: Active and passive transport. Different types of transporters. Endocytosis.
3. Intracellular Trafficking: The function of subcellular organelle in protein synthesis. Endoplasmic reticulum, Golgi complex, Lysosomes etc.
4. Cell division: Bacterial cell division by binary fission. Mitosis in eukaryotes, stages of mitosis, Meiosis.
5. Cell cycle: Phases of eukaryotic cell cycle: G1, S, G2 and M phase, cell cycle control system.
6. Cell-cell adhesion: Extracellular matrix, intercellular recognition and cell adhesion, cell junctions

Books Recommended

1. Cell and Molecular Biology: concepts and experiments / By Gerald Karp, Kevin Witt - Wiley, Hoboken, 2008 (5th Edition)
2. Microbiology: An Introduction / By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)

MBG 207: Microbiology of Food and Frozen Food

(2 Credit)

1. **Food and Food-Borne Microbes:** introduction to various types of foods; introduction to food-borne diseases
2. **Factors Affecting Microbial Growth in Foods:** intrinsic and extrinsic parameters
3. **Food Preservation:** general principle; physical methods of preservation (high temperature, low temperature, drying and radiation); chemical preservatives and natural antimicrobial compounds; biological control of food borne microorganisms.
4. **Spoilage of food and frozen food:** cereal and cereal products; sugar and sugar products; vegetables and fruits; meat and meat products; fish and other sea-foods; poultry; microbiology of raw and frozen milk, heated canned foods.
5. **Effects of Freezing/Thawing on Foods:** basic concepts of freezing and thawing; influence of frozen temperature and time on foods; thawing methods; freezing preservation: influence on food quality, physical and chemical reactions during freezer storage
6. **Response of Microorganisms to Freeze-Thaw Stress:** factors affecting microbial survival; nutritional status, age and growth rate; freeze injury; mechanisms of freeze damage; effect of freezing on microorganisms.

Books Recommended

1. Microbiology of Frozen Foods / Edited by R.K. Robinson – Elsevier Applied Science Publishers

MBG 208: Applied Mycology

(2 Credit)

1. **Introduction to the Fungi:** A brief history of mycology; what are fungi and organisms related to fungi
2. **Morphological Characteristics of Fungi:** Structure of fungi; Characteristics of fungal organelles and function
3. **Fungal Taxonomy:** Detailed description of major fungal subdivisions: Mastigomycotina, Zygomycotina, Basidiomycotina, Deuteromycotina, and Ascomycotina.
4. **Fungal Reproduction:** Fungi genetics; Asexual and sexual reproduction; Growth and development of fungi; Life cycle of fungi.
5. **Fungi Physiology and Metabolism:** Nutrition in fungi; Aerobic and anaerobic respiration in fungi.
6. **Laboratory Methods in Mycology:** Collection and transportation of fungal samples; Storage and processing of samples for mycological studies; Media and growth requirements, Methods for microscopic examination; Colonial appearance and microscopic features, and Methods for laboratory identification.
7. **Fungal Diseases in Man, Animals and Plants:** Medically important species; Fungal diseases in man – hypersensitivity, mycotoxicoses and mycoses; General aspects of fungal immunology and pathology; Antifungal therapeutic agents; Animal and plant pathogens
8. **General Economic Importance of Fungi to Man and the Environment:** Fungal metabolites; Importance of fungi in agriculture (*e.g.*, mycorrhiza), food industry, medicine (pharmaceuticals), environment, and biotechnology.

Books recommended

1. Introduction to Fungi / By John Webster and Roland Weber – Cambridge University Press, The Edinburgh Building, Cambridge, 2007 (3rd Ed.)
2. Modern Mycology / By JW Deacon – Blackwell Scientific Ltd., Oxford, 1997 (3rd Ed.)
3. Fundamental Medical Mycology / By E Reiss, HJ Shadomi and GM Lyon – Wiley-Blackwell, 2012.
4. Introductory Mycology / By Constantine J Alexopoulos, Charles W Mims and Meredith M. Blackwell – John Wiley & Sons, Inc., 1996 (4th Ed.)
5. Fungi: Biology and Applications / By Kevin Kavanagh – John Wiley & Sons, Inc., 2011 (2nd Ed.)
6. Clinical Mycology / By Elias J Anaissie, Michael R McGinnis and Michael A Pfaller – Churchill Livingstone, 2009 (2nd Ed.)
7. Applied Mycology / By Mahendra Rai and Paul Dennis Bridge – Centre for Agriculture and Biosciences International (CABI), 2009 (1st Ed.)

MBG 209: Practical

(4 Credit)

Part A (Growth Measurement)

1. Techniques of pipetting and dilution
2. Determination of quantitative viable cells by serial dilution technique (spread plate and pour plate) and making a growth curve
3. Techniques of enumeration of microorganisms: improved Neubauer counting chamber; Miles and Misra technique
4. Turbidimetric estimation of bacterial growth

Part B (Environmental Influences)

1. Effect of temperature on growth
2. Effect of heat on vegetative cells, spores of bacteria and on spores of yeast and mold
3. Effect of osmotic pressure on growth
4. Effects of pH, energy source and buffer on growth

Part C (Metabolic Activities of Microorganisms)

1. Starch, lipid, casein and gelatine hydrolysis tests
2. Carbohydrate (LDS) fermentation
3. MIU, KIA and IMViC tests
4. Nitrate reduction, oxidise, catalase and litmus milk reaction tests
5. Antimicrobial sensitivity test of microorganisms (qualitative)
6. Identification of unknown bacterial culture with the help of Bergey's Manual of Systematic Bacteriology

Part D (Basic Microbial Genetics)

1. Protoplast fusion test
2. Detection of genetic material by staining
3. Test for enzyme induction
4. Isolation or drug resistant mutant

Part E (Medical Microbiology)

1. Microscopic study of parasites
2. Microscopic study of the pathogenic microorganisms presents in air, water and soil (Gram reaction, morphology, motility etc.)
3. Microbial flora of throat and skin
4. Identification of human staphylococcal pathogens
5. Identification of human streptococcal pathogens

Part F (Fundamental Cell Biology-I)

1. Observing Permanent slides
2. Mitosis and Meiosis
3. Preparation of permanent slides

Part G (Microbiology of Food and Frozen Food)

1. Quantitative examination of bacteria in raw and pasteurized raw milk
2. Methylene blue reduction test
3. Microbiological analysis of fermented foods and nonfermented foods
4. Detecting *Salmonella* spp. in poultry

Part H (Applied Mycology)

1. Microscopic observation of Disease causing fungi
2. Cultivation and identification of disease causing fungi
3. Industrially important fungi

MBG 210: Viva Voce

(2 Credit)

Extra- departmental Courses

MBG 211: Biostatistics and Calculus

(4 Credit)

1. **Organizing and Summarizing Data:** some basic concepts; statistics, biostatistics, variables, population and sample, random samples, distribution; tabulation, processing and summarizing of numerical data; the frequency – distribution, graphical representation of frequency table measures of central tendency; measures of dispersion, skewness of kurtoses; measures or exploratory data analysis by plotting
2. **Probability:** introduction; some elementary probability; the binomial distribution; the normal distribution; the Chi-square distribution; the distribution of Student's
3. **Hypothesis Testing/Statistical Inference:** statistical hypothesis: simple and composite hypothesis; significance test; type-I and type-II errors; power of a test; p-value; testing hypothesis of a single population mean, proportion, variance; comparison between two population means and between two population variance
4. **Analysis of Frequency using λ^2 Distributions:** the λ^2 criterion; tests of goodness-of-fit; homogeneity of two-cell samples; tests of independence

5. **Correlation, Simple Regression and Multiple Regression:** correlation: linear regression model, evaluating the regression equation, the multiple regression model; evaluating multiple regression model; choosing independent variables for multiple regression model
6. **Analysis of Variance:** experiment; experimental unit; treatment; replication analysis of variance for the completely randomized design; the randomized complete block design; the Latin square design
7. **Statistical Methods in Epidemiology:** basic incidence measures; risk and rate; prevalence measures; measures of association; risk ratio or relative risk; exposure odds ratio; risk odds ratio; measures of potential impact; attributable risk
8. **Survival Analysis:** introduction; basic designs follow-up studies, cross-sectional studies and case control studies; survival function; hazard function; the product limit estimate of survival function; the life table analysis; the log rank test for comparing survival distributions
9. **Calculus for biology:** Fundamental theorem of calculus, simple limit ideas, functions and continuity, differentiation and applications, simple integration and applications, matrices and vectors, linear equation systems, sample models: predator prey model, disease model, cancer model.

Books recommended

CM 222H: Biologically Important Organic Compounds (2 Credit)

1. **Fats and Oils:** occurrence, composition of fats and oils; hydrolysis of fats and oils; various use of fats and oils; saponification of fats and oils; Tiodine value and saponification value of fats and oils; saturated and unsaturated fatty acids
2. **Amino Acids, Peptides and Proteins:** structure and configuration of amino acids; isoelectric point preparations; reactions of amino acids and peptides; C-terminal and N-terminal residue of peptides; proteins, their classifications and functions; basic structure of proteins
3. **Carbohydrates:** definition, classification and composition of monosaccharides; ring structure of monosaccharides and their conformations; action of acids and bases on sugars: epimers, anomers and anomeric configurations; reactions of monosaccharides, disaccharides and trisaccharides, their structure and compositions; polysaccharides: cellulose, starch and their constituents
4. **Vitamins:** occurrence, symptoms due to deficiency of vitamins; chemistry of vitamin: A, B1, B2, B6, B12 and E their structures
5. **Synthesis of Following Drugs and Their Actions in Biological Systems:** sulpha drugs, sulphonamide sulphapyridine, sulphaguanidine, sulphamethazine and sulphathiazole
6. **Antimaterials:** plasmaquine, mepacrine, proguanil and quinine
7. **Antibiotics:** penicillin, amoxycillin, streptomycin, chloromycetin, etc.
8. **Insecticides, Fungicides and Herbicides:** organic compounds: DDT, gammexane, methoxychlor and heptachlor; organophosphorous compounds; malathion, parathion, dimecron and diazinon; carbamates; 2,4-D (2,4-dichloroacetic acid)
9. **Organic Pollutants**
10. **Purines and Nucleic Acids:** structure of uric acid, nucleosides and nucleotides: DNA and RNA

Books Recommended

1. Chemistry of Organic Natural Products, Vol. I & II –Agarwal OP
2. Organic Chemistry – Morrison RT & Boyd RN
3. Organic Chemistry, Vol. I & II – Finer LL
4. Organic Chemistry – Handrickson JB & Pine SH
5. Other Industrial Chemistry for Topics-7

CMGL 101 H: General Chemistry Laboratory

(2 Credit)

Physical Chemistry

1. Determination of the molar mass of carbon tetrachloride by Duma's method
2. Determination of enthalpy of neutralization of acid calorimetrically
3. Determination of partition coefficient of 12 between water and carbon tetrachloride

- Investigation of the variation of conductance of a weak electrolyte with concentration
- Investigation of the effect of reactant concentration on the rate of the reaction between thiosulphate ion and H^+ ion and determination of the reaction

Organic Chemistry

- Determination of the melting point of the organic compound
- Determination of presence of nitrogen, sulphur and halogens in organic sample
- Identification of functional groups in organic compounds

Courses for the Third Year BS (Honours)

MBG 301: Virology-I

(2 Credit)

- Introduction to Virology:** brief history and development of virology.
- Nature of Virion:** morphology, physical properties and chemical composition of virion.
- Nomenclature and Classification of Animal and Plant Viruses.**
- Virus Cultivation:** cultivation and quantification of animal and bacterial viruses, purification and identification of virus; one step growth curve; inclusion bodies
- Virus Replication:** steps in virus replication; multiplication and gene expression of DNA and RNA viruses
- Pathogenesis of Viral Diseases:** infection initiation, entry, spread, organ invasion and tropism. Pattern of infection.
- Bacteriophages:** overview of bacteriophages; genome organization and multiplication of RNA and DNA bacteriophages; temperate bacteriophages; lytic and lysogenic cycle; transposable phages.
- Prevention and Treatment of Viral Infections:** viral vaccines; interferon: induction and action of interferons; antiviral chemotherapy.
- Viroids and Prions:** general properties and diseases caused by viroids and prions.

Books Recommended

- Brock Biology of Microorganisms (International Edition) / By Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark – Pearson Prentice Hall, 2012 (12th Ed.)
- Principles of Molecular Virology / By Alan J. Can – Elsevier Academic Press., New York, 2016 (6th Ed.)
- Fields Virology (Vol. I and II) / Edited by David M. Knipe, Peter M. Howley, Diane E. Griffin, – Lippincott Williams, New York, 2007 (5th Ed.)
- Fundamental Virology / Edited by Bernard N. Fields and David M. Knipe – Raven Press, New York, 1991 (2nd Ed.)

MBG 302: Microbial Physiology and Metabolism-II

(2 Credit)

- The Regulation of Metabolic Pathways:** Patterns of Regulation of Metabolic Pathways, Kinetics of Regulatory and Nonregulatory Enzymes, Conformational Changes in Regulatory Enzymes, Regulation by Covalent Modification
- Carbohydrate synthesis:** gluconeogenesis pathway and regulation.
- Metabolism of Lipids and Nucleotides,** biosynthesis of fatty acids; role of cofactors in fatty acid biosynthesis; pathway to biosynthesis of mevalonate, squalene and sterols, biosynthesis of purines and pyrimidines; regulation of purine and pyrimidine biosynthesis
- Biosynthesis of Amino Acids:** the glutamate and ketoglutarate family; the aspartate and pyruvate families; the serine-glycine family; aromatic amino acids.
- Photosynthesis:** The Phototrophic Prokaryotes, The Purple Photosynthetic Bacteria, The Green Sulfur Bacteria (Chlorobiaceae), Cyanobacteria and their Chloroplasts, Efficiency of Photosynthesis, Photosynthetic Pigments, The Transfer of Energy from the Light Harvesting Pigments to the Reaction Center, The Structure of Photosynthetic Membranes in Bacteria.
- Inorganic Metabolism:** Assimilation of Nitrate and Sulfate, Dissimilation of Nitrate and Sulfate, Nitrogen Fixation, Lithotrophy (aerobic chemolithotroph; hydrogen and CO oxidizers; ammonia, sulphur and ferrous ion oxidizers; facultative obligate chemolithotrophs)

Book Recommended

1. The Physiology and Biochemistry of Prokaryotes / By David White, James Drummond and Clay fuqu – Oxford University Press, 2011 (4th Ed.)
2. Microbial Physiology / By Albert G. Moat and John W. Foster – John Wiley, New York ; Chichester 1995 (3rd Edition)
3. Bacterial Metabolism / By Gerhard Gottschalk – Springer-Verlag, New York 1979 (2nd Ed.)
4. Microbiology / By Michael J. Pelczer JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
5. Microbiology: Concepts and Applications / By Michael J. Pelczer JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
6. Lehninger Principles of Biochemistry / By David L. Nelson and Michael M. Cox – W.H. Freeman and Company, New York 2013 (6th Ed.)

MBG 303: Microbial Molecular Genetics

(2 Credit)

1. **Mutation:** mutation rate; types of mutations; detection of mutations; mutagenic agents; screening chemicals for mutagenicity; molecular basis of mutagenesis; mutation induced by chemical and radiations
2. **DNA Repair Mechanisms:** nature of DNA damage; light-dependent repair; excision repair; mismatch repair; post-replication repair; error-prone repair system; SOS repair.
3. **Gene Transmission in Bacteria:** mutant phenotypes in bacteria; basic test for transformation, conjugation and transduction; transformation and gene mapping; conjugation and gene mapping; transduction and gene mapping; the evolutionary significance of sexuality in bacteria
4. **Regulation of Bacterial Gene Expression:** constitutive, inducible and repressive gene expression; positive and negative control; lactose and histidine operon in *E. coli*; induction and catabolite repression; tryptophan operon in *E. coli* repression and attenuation; arabinose operon in *E. coli*; transcriptional, translational and post-translational regulatory mechanisms.
5. **Genetic Recombination:** types of recombination, models of general recombination; molecular basis of homologous and non-homologous recombination
6. **Transposable Genetic Elements:** transposable elements in prokaryotes; IS elements; composite transposons, Tn3 element, mutagenic effects of bacterial transposable elements, the medical significance of bacterial transposons; transposable elements in eukaryotes: Ac, Ds and Dt elements in maize; P elements and hybrid dysgenesis in *Drosophila*.

Books recommended

1. Principles of Genetics / By Eldon John Gardner, Michael J. Simmons and D. Peter Snustad – John Wiley and Sons, New York 1991 (8th Edition)
2. Molecular Biology of the Gene / By James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick – Pearson, San Francisco 2013 (7th Ed.)
3. Lewin's Genes XI / By Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick – Jones & Bartlett Learning, 2013 (11th Ed.)
4. Genetics / By D. Peter Snustad and Michael J. Simmons – John Wiley & Sons, Inc., 2012 (6th Ed.)

MBG 304: Medical Microbiology-II

(2 Credit)

1. **Clinical Manifestation, Pathogenesis, Virulence Factors, and Control of the following Pathogenic Microbes:** *Streptococcus spp.* *Staphylococcus spp.*; *Corynebacterium diphtheriae*; *Mycobacterium tuberculosis*; *Vibrio cholerae*; *Escherichia coli*; *Salmonella, typhi*; *Neisseria spp.*; *Treponema pallidum*, *Plasmodium*
2. **Bacterial strategies for evading or surviving host**
3. **Brief introduction to clinically important parasites:** *Giardia*; *Entamoeba*, *Leishmania*, *Taenia*, *Plasmodium spp*

Books Recommended

1. Bacterial Pathogenesis: A Molecular Approach / By Abigail A. Salyers and Dixie D. Whitt – ASM Press, 2002 (2nd Ed.)
2. Jawetz, Melnick and Adelberg's Medical Microbiology / Edited by Karen C. Carroll, Stephen A. Morse, Timothy Mietzner, Steve Miller – McGraw Hill Education, 2016 (27th Ed.)

3. Medical Microbiology / By Robert F. Boyd and Joseph J. Marr – Little Brown and Company, Boston 1980 (2nd Ed.)
4. Manual of Clinical Microbiology / Edited by Patrick R. Murray, Ellen Jo Baron, Michael A. Pfaller, Fred C. Tenover and Robert H. Yolken – ASM Press, Washington D.C., 1999 (7th Ed.)
5. Medical Microbiology / By Mims C, Playfair J, Roitt I, Wakelin D and Williams R.

MBG 305: Immunology-I

(4 Credit)

1. **History and Introduction to Immunology:** history and development of immunology; introduction to immune system; basic concept of innate and adaptive immunity; cellular and humoral immunity.
2. **Cells Involved in Immune Response:** general features and functions of lymphoid cells; mononuclear phagocytes; antigen presenting cells; polymorphs; mast cells; platelets
3. **Lymphoid Systems:** primary and secondary lymphoid tissue; primary lymphoid organs; secondary lymphoid organs and tissues
4. **Innate Immunity:** phagocytosis: process and evasion strategies, complement systems: activation, function and regulation of complements.
5. **Inflammation:** patterns of cell migration and inflammation and their control.
6. **Antigens:** general properties of antigen; antigenic determinants; haptens.
7. **Immunoglobulins:** basic structure and function of immunoglobulin; immunoglobulin classes and subclasses; physiochemical properties, distribution and functions of different classes and subclasses of immunoglobulin; memory B cell; genetic basis of antibody heterogeneity; antibody class switching.
8. **Membrane Receptors for Antigens:** B cell surface receptors for antigens; T cell receptors (TCR major histocompatibility complex (MHC); antigens structure; functions of MHC class I and class II molecules; gene map of MHC antigens; processing and presentation of peptides by MHC molecule, antigen recognition; antigen-antibody interaction ; forces of antigen-antibody binding; haplotype restriction of T cell reactivity
9. **Lymphocyte activation:** interaction of T lymphocytes and APC; signals for T cell activation; B cell response to thymus dependent and -independent antigens; B cell activation by surface Ig and T cell
10. **Cytokines and chemokines:** General properties, Families of cytokines and associated receptor molecules, cytokine action and network interaction.
11. **Immune regulations:** regulation of immune response by antigens, antibody, antigen presenting cells and lymphocytes; idiotypic regulation of immune response.
12. **Immunity to Infections:** immunity to extracellular and intracellular bacteria; bacterial survival strategies; immunity to viral infection; innate and specific immune response to viruses; strategies for evading immune defences by viruses; immunity to parasitic infection
13. **Immunological Techniques:** precipitation reactions; immunodiffusion; immuno-electrophoresis; agglutination; co-agglutination; haemagglutination; complement fixation; direct and indirect immunofluorescence; immunoassay; immunoblotting; immuno-precipitation; fluorescence-activated cell sorter (FACS), experimental animal models.
14. **Monoclonal antibodies:** production of hybridoma; screening, clonning and large-scale production of monoclonal antibodies.

Books recommended

1. Immunology / By Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt – Mosby Elsevier, 2007 (7th Ed.)
2. Roitt's Essential Immunology / By Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt – Wiley Blackwell, 2011 (12th Ed.)
3. Kubys Immunology / By Judith A. Owen, Jenni Punt, Sharon A. Stranford – W.H. Freeman and Company, New York, 2009 (7th Ed.)
4. Advanced Immunology / By David Male et al – Gower Medical pub., New York, 1992
5. Text Book of Immunology: an Introduction to Immunochemistry and Immunobiology / By James T. Barrett – Mosby, New York, 1978 (3rd Ed.)

MBG 306: Agriculture Microbiology**(2 Credit)**

1. **Major Groups of Microorganisms in Soil:** bacteria; fungi; actinomycetes; algae; viruses.
2. **Role of Microbes in Soil Fertility and Plant Nutrition:** Role of microbes on physico-chemical properties of soil; use of microbial metabolites as major nutrients; the effect of growth regulators produced by microorganisms; the liberation of unavailable nutrients from soil organic matter and mineral.
3. **Microbial Degradation of Cellulose, Hemicellulose and lignin.**
4. **Biogeochemical Cycling of Nutrient Elements:** carbon cycle, hydrogen cycle, oxygen cycle, nitrogen cycle, sulphur cycle, phosphorus cycle.
5. **Biofertilizer and bioinoculants;** Plant growth promoting rhizobacteria (PGPR)
6. **Pesticides in the Agricultural field:** types and uses of pesticides; effect of pesticides on soil microorganisms.
7. **Plant Pathogens and Growth Inhibitory Microbes:** the concept of disease in plants; diagnosis and control of plant diseases. Production of phytotoxic substances by saprophytes and parasites; competition of microorganisms with plants for essential nutrients.

Books Recommended

1. An Introduction to Soil Microbiology /By Marhtin Alexander – John Wiley, New York 1977 (2nd Ed.)
2. Soil Microorganisms / By Timothy R.G. Gray and S.T. Williams – Longman Group United Kingdom, 1971
3. Soil Microorganisms and Plant Growth / By Subba Rao NS – I.B.H., New Delhi
4. Plant Microbiology / By R Campbell – Edwards Arnold, London, 1985
5. Plant Diseases / By Shing RS – Oxford and IBH, Delhi 1983 (5th Ed.)
6. Plant Pathology / By George N. Agrios – Academic Press, New York 2005 (5th Ed.)
7. Microbial Ecology: A Conceptual Approach / Edited by J. M. Lynch and N. J. Poole – John Wiley & Sons, New York, 1979
8. Biological Indicators of Soil Health / By C. Pankhurst, B. Doube and V. Gupta – CAB international, New York, 1997

MBG 307: Molecular Cell Biology**(2 Credit)**

1. **Chemical signaling between cells:** Three different strategies of chemical signalling, local chemical mediators, hormones and neurotransmitters, signaling mediated by intracellular receptors, mechanism of steroid hormone action, signaling mediated by cell surfaces, cyclic AMP and calcium ions as second messengers, involvement of G-proteins in signal transduction, target cell adaptation.
2. **Cell cycle regulation:** Regulation of cell cycle by CDK and associated proteins, cell cycle check points, regulation of passage through check points, effects of cell cycle deregulation.
3. **Apoptosis:** Extrinsic and intrinsic pathways, excessive and insufficient apoptosis.
4. **Protein turnover:** proteasome, chaperon; protein degradation, ubiquitination, Posttranslational processing of proteins: folding, cleavage, chemical modification.
5. **Stem cell transplantation:** Embryonic and adult stem cells; unipotency and pluripotency; the isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells; ethical views surrounding human embryonic stem cell research.

Books Recommended

1. Cell Biology / By Gerald Karp – Wiley (7th Edition International Student Version)\
2. Molecular Biology of the Cell / By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter – Garland Science, 2007 (5th Ed.)
3. Molecular Biology of the Gene / By James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick – Pearson, San Francisco 2013 (7th Ed.)
4. Lewin's Genes XI / By Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick – Jones & Bartlett Learning, 2013 (11th Ed.)

MBG 308: Fermentation Technology**(2 Credit)**

1. **Introduction to Fermentation Processes:** range of fermentation processes; chronological development of the fermentation industry; component parts of fermentation process.
2. **Fermenter / Bioreactor design:** bioreactor types and configuration, impeller designs and baffles, agitation, aeration, $k_L a$ etc
3. **Media for industrial fermentations:** Energy and carbon sources, nitrogen, minerals, addition of precursors and metabolic regulators to media, oxygen requirements, antifoams, medium optimization; submerged, surface and solid state fermentations.
4. **Inoculum Development:** Inoculum preparation and scale up for bacterial, yeast and fungal processes.
5. **Sterilization of Fermenters and Media:** medium sterilization, the design of batch sterilization processes; the design of continuous sterilization, processes; sterilization of the fermenter; sterilization of feed and air.
6. **Microbial growth kinetics:** rate equations for cell growth, substrate utilization and product formation, comparison amongst batch, fed-batch and continuous culture processes.
7. **Instrumentation and Control:** control systems: manual, automatic and combinations of methods of control. Methods of control of process variables: temperature, pH, flow measurement, pressure measurement and control, agitation and aeration, foam sensing, measurement and control of dissolved oxygen; exit-gas analysis; redox and carbon dioxide electrodes.

Books Recommended

1. Principle of Fermentation Technology / By Peter F Stanbury, Allan Whitaker and Stephen J Hall – Butterworth, New Delhi 2003 (2nd Ed.)
2. Fermentation Microbiology and Biotechnology / By E. M. T. EI-mansi, C. F. A. Bryce and Arnold Demain – Taylor and Francis, London 2007 (2nd Ed.)
3. Modern Industrial Microbiology and Biotechnology / By Nduka Okafor – CBC Press, New Hampshire, 2007 (1st Ed.)

MBG 309: Enzymology**(2 Credit)**

1. **Properties and Functions of Enzymes:** remarkable properties; catalytic power; specificity; different forms; cofactors, coenzymes and vitamins
2. **Nomenclature and Classification of Enzymes:** general classification; isoenzymes; multi-enzymes;
3. **Structure of Enzymes:** primary, secondary, tertiary and quaternary structure; folding and domains; molecular chaperones
4. **Enzyme Regulation:** allosteric enzymes; structure, properties and regulations.
5. **Catalysis and Mechanism of Action of Enzymes:** active site; substrate binding; general acid-base catalysis; covalent catalysis; non-protein catalytic groups and metal ions.
6. **Kinetics of Enzyme-Catalyzed Reactions:** factors influencing catalytic activity; simple enzyme kinetics with single and multi-substrate; Michaelis-Menten kinetics; turnover number, K_m and V_{max} ; other influences on enzyme activity; pH, temperature, fluid forces, chemical agents and irradiation.
7. **Enzyme Inhibition and deactivation:** competitive, non-competitive and un-competitive inhibition; deactivation models; strategies for enzyme stabilization.

Books Recommended

1. Lehninger Principles of Biochemistry / By David L. Nelson and Michael M. Cox – W.H. Freeman and Company, New York 2013 (6th Ed.)
2. Biochemical Engineering Fundamentals / By James E. Bailey and David F. Ollis – McGraw-Hill, New York, 1986 (2nd Ed.)

MBG 310: Pharmaceutical Microbiology**(2 Credit)**

1. **Environment of Pharmaceutical industry:** atmosphere, water, raw materials, personnel, building, etc.
2. **Microbial Spoilage, Deterioration and Preservation of Pharmaceutical Products:** mixture, suspension, sterile products, cosmetics and toiletry products, tests for sterility. MIC and MBC; pyrogen and pyrogen tests.

3. **Antibiotics:** Characteristics, Mode of Action, Targets and their inhibition. Principle of Testing Methods: Conventional Testing Methods, Commercial Testing Systems. Determination of Potency/Concentration of Antibiotic and Antimicrobial Preservatives.
4. **Mechanism of Antibiotic Resistance:** Enzymatic inactivation, Active efflux, Modification or Protection of the target, Failure to activation. Regulation, and Transfer of Resistance Genes. Assay of Specific Resistance: Phenotypic and Genotypic Methods.
5. **Design and maintenance of an aseptic unit laboratory/processing area.**
6. **Overview of biopharmaceutical Products:** insulin, growth hormone, vaccines, interferon and human globulins.

Books Recommended

1. Hugo and Russell's Pharmaceutical Microbiology / Edited by Stephen P Denyer, Norman A Hodges and Sean P German – Blackwell Scientific Pub., Oxford 2004 (7th Ed.)
2. Cooper and Gunn's Dispensing for Pharmaceutical Students / By Cooper, John W; Gunn, Colin; Carter, Sidney James – Pitman Medical, London 1975 (11th Ed.)
3. Preservatives in the food pharmaceutical and environmental industries / By R.G.Board; M.C.Allwood; J. G. Banks – Blackwell, London 1987
4. Essays in Applied Microbiology / Edited By J. R. Norris; M. H. Richmond – Wiley, New York, 1981

MBG 311: Advanced Food Microbiology

(2 Credit)

1. **Indicators of Food Microbial Quality and Safety:** criteria for selecting indicators; general character of indicator microbes and microbial products.
2. **Food-Borne Diseases:** (Epidemiology, symptoms, control) Gram-positive bacteria: *Bacillus cereus*, *Campylobacter* spp. *Staphylococcus* spp., *Listeria* spp. and *Clostridium* spp.; Gram-negative bacteria: *Yersinia enterocolitica*, *Aeromonas* spp. *Pleciomonas*, *Escherichia coli* (*EIEC* and *EHEC*) and *Campylobacter*.
3. **Non bacterial agents causing food borne diseases:** (Epidemiology and symptoms) Mycotoxins, Viral agents (Hepatitis A, E, Rotavirus, Norovirus, Nipahvirus)
4. **Isolation and Identification of Pathogens and spoilage organisms in food and frozen food:** conventional bacteriological identification methods, methods for detecting food poisoning toxins, Nanotechnology in food microbiology (nanotechnology in food safety, development of nanotechnology to test food quality).
5. **Bacteriophage in the control of food and water borne pathogens.**
6. **Fermented Foods: Benefits, health effect and preparation of fermented foods:** fermented dairy (yogurt and cheese), vegetables (sauerkraut), meat (sausages), and fish products. Oriental fermented foods: idli, and tofu.

Books Recommended

1. Microbiology of Frozen Foods / Edited by Robinson RK – Elsevier Applied Science Publishers, London, 1985
2. Food Microbiology / By William C. Frazier and Dennis C. Westhoff – McGraw-Hill, New Delhi 1998 (4th Edition)
3. Food Microbiology / By M. R. Adams and M. O. Moss – Royal Society of Chemistry, Cambridge 2000 (2nd Ed.)
4. Manual for the isolation and Identification of Fish Bacterial Pathogens / By G.N. Frerichs and Stuart D. Miller – Pisces Press, Stirling, 1993
5. Modern Food Microbiology / By Martin J. Loessner, David A. Golden and James M. Jay – Springer, 2007 (7th Ed.)

MBG 312: Practical

(4 Credit)

Part A (Virology-I)

1. Cultivation and enumeration of bacteriophages
2. Isolation of bacteriophages from raw sewage
3. Detection of HBsAg from patients serum by serological methods
4. Isolation of TMV virus and infecting plants

Part B (Microbial Physiology and Metabolism-II)

1. Relationship of free oxygen to microbial growth
2. Anaerobic culture of bacteria
3. Degradation of polymer by exoenzymes
4. Actions of antiseptics, disinfectants, UV light and photo-reactivation and anti-metabolites

Part C (Microbial Molecular Genetics)

1. Isolation of plasmids and chromosomal DNA
2. Detection of DNA by agarose gel electrophoresis
3. Transformation of *E. coli* by plasmid
4. Study of gene expression in *E. coli*

Part D (Medical Microbiology-II)

1. Isolation, identification and antibiotic sensitivity pattern of pathogenic microorganisms from clinical specimens: (a) stool, (b) urine, (c) pus, (d) blood, (e) CSF and (f) biopsy

Part E (Immunology-I)

1. Preparation of bacterial whole cell extract
2. Preparation of outer membrane protein
3. Immunization protocol for animals
4. Collection of serum and plasma
5. Separation of blood leucocytes
6. Test for cell viability
7. Phagocytosis by neutrophils

Part F (Agricultural Microbiology)

1. Microbial population of soil, rhizosphere and rhizoplane
2. Denitrification and ammonification
3. Nitrogen fixation test
4. Identification of plant pathogens

Part G (Molecular Cell Biology)

To be added later

Part H (Fermentation Technology)

1. Production of microbial extracellular enzymes
2. Production of SCP
3. Production of antibiotics
4. Production of alcohol from molasses

Part I (Enzymology)

1. Determination of enzyme activity (qualitative and quantitative)
2. Determination of kinetic properties of an enzyme
3. Determination of activators and inhibitors of enzymes
4. Determination of molecule weight and substrate specificity of enzyme

Part J (Pharmaceutical Microbiology)

1. Microbiological assay of pharmaceutical raw material
2. Microbiological assay of pharmaceutical solids, ointments and oral liquids
3. Bioassay of potency of antibiotics
4. Sterilization and sterility test; pyrogen test

Part K (Advanced Food Microbiology)

1. Detection of *B. cereus* and *S. aureus* in fast foods
2. Detection of *E. coli* and *Aeromonas hydrophila* in salad dressings
3. Isolation of *Aspergillus flavus* from oil seeds
4. Detection of haemolysin and phospholipase C (toxins) from *B. cereus*

Courses for Fourth Year BS Honors

MBG 401: Virology-II

(4 credit)

1. **Animal Viruses:** Brief introduction to different classes of viruses
2. **Viral Infections to the Respiratory System:** common cold; influenza; measles; mumps; rubella; chicken pox; shingles
3. **Viral Infections to the Gastrointestinal Tract:** viral diarrhoea
4. **Arthropod-Borne Diseases:** diseases caused by Japanese encephalitis virus, yellow fever virus.
5. **Herpes Viruses:** general properties; pathogenesis; diseases caused by HSV-I, EBV and CMV.
6. **Hepatitis Viruses:** general properties; pathogenesis; transmission; diseases caused by HAV, HBV, HCV, HDV, HEV and HGV
7. **Hepatitis B Virus:** detail of virion structure; genome organization; replication; viral proteins; pathogenesis; genetic variants; epidemiology; transmission; prevention; clinical diagnosis
8. **Nononcogenic Retroviruses:** HIV: structure; genome organization; transmission; epidemiology; disease pathogenesis; drugs; treatment strategy; vaccine approaches.
9. **Cellular Oncogenes and Oncogenic Viruses:** RNA tumour viruses: general features and classification; retroviridae genome structure; replication of HTLV; T cell transformation; DNA tumour viruses; mechanism of oncogenic transformation by DNA viruses; tumour suppressor gene
10. **Human Papilloma viruses:** General features, epidemiology and oncogenic potential.
11. **Influenza Viruses:** general properties and replication; antigenic shift and drift; pathogenesis; epidemiology and vaccine approaches.

Books Recommended

1. Fields Virology (Vol. I and II) / Edited by David M. Knipe, Peter M. Howley, Diane E. Griffin, – Lippincott Williams, New York, 2007 (5th Ed.)
2. Jawetz, Melnick and Adelberg's Medical Microbiology / Edited by Karen C. Carroll, Stephen A. Morse, Timothy Mietzner, Steve Miller – McGraw Hill Education, 2016 (27th ed.)
3. Viral Hepatitis / Edited by Howard C. Thomas, Anna S. F. Lok, Stephen A. Locarnini, Arie J. Zuckerman – Wiley Blackwell, 2013 (4th ed.)
4. Principles of Virology (2 Vol. Set) / By S. Jane Flint, Lynn W. Enquist, Vincent R. Racaniello, Anna Marie Skalka – ASM Press, 2008 (3rd ed.)
5. Principles of Molecular Virology / By Alan J. Cann – Academic Press, 2016 (6th ed.)

MBG 402: Immunology-II

(2 Credit)

1. **Immunological tolerance:** T-and B-cell development: Early development in thymocyte and bone marrow; mechanism of tolerance; thymic tolerance to self antigens; B cell tolerance; artificially induced tolerance
2. **Immunodeficiency:** primary immunodeficiency; deficiencies of innate immunity; primary B cell deficiency; primary T cell deficiency; combine immunodeficiency; secondary immunodeficiency
3. **Hypersensitivity:** hypersensitivity type-I, type-II, type-III and type-IV reactions
4. **Transplantation:** barriers of transplantation; law of transplantation; role of T lymphocytes in rejection; prevention of rejection
5. **Tumour Immunology:** Surface markers of tumour cell; immune response to tumour cells; lymphoproliferative disorders due to tumour growth.
6. **Autoimmunity and Autoimmune Diseases:** association of autoimmunity with diseases; genetic factors in pathogenesis; aetiology and treatment of autoimmune diseases. Diagnostic and Prognostic Value of Autoimmune Diseases

Books Recommended

1. Immunology / By Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt – Mosby Elsevier, 2007 (7th Ed.)
2. Roitt's Essential Immunology / By Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt – Wiley Blackwell, 2011 (12th Ed.)
3. Advanced Immunology / By David Male et al – Gower Medical pub., New York, 1992
4. Immunology: An Introduction / By Tizard, Ian R – Saunders College Pub., New York, 1984
5. Kuby's Immunology / By Judith A. Owen, Jenni Punt, Sharon A. Stranford – W.H. Freeman and Company, New York, 2009 (7th Ed.)

MBG 403: Environmental Pollution and Bioremediation

(2 Credit)

1. **Biodeterioration of Materials:** basic concepts, factors involved in biodeterioration; biodeterioration of leather, wool, fur, feather, stones, plastics and rubber; microbial production of bioplastics; control of biodeterioration: physical, chemical and biological methods.
2. **Biodegradation of Recalcitrants:** xenobiotic chemicals in the environment; biodegradable, persistent and recalcitrant wastes; structure-recalcitrance relationship; concept on ring cleavage, factors affecting microorganisms to degrade xenobiotic, removal of substituent groups and ring opening in model molecules; **chloro-organics; organic dyes; phenols; petroleum hydrocarbons.**
3. **Enrichment and Isolation of pollutant degrading Microbes:** recent approaches to enrich and isolate microbes having catabolic properties.
4. **Approaches to Bioremediation:** environmental modification for bioremediation; microbial seeding and bioengineering approaches to the bioremediation of pollutants; monitoring of the bioremediation of xenobiotic pollutants
5. **Waste Treatment Technologies:** physical, chemical and biological treatment; activated sludge; advanced treatments; biological removal of nitrogen and phosphorous.
6. **Biotechnological Aspects for Effluent Treatment:** genetic manipulation, enzyme and specialized bacteria; biodegradability testing.
7. **Toxicity Testing in Wastewater:** impacts of toxicity on wastewater treatment; heavy metals organic toxicants; enzymatic assays and microbial bioassays.

Books Recommended

1. Microbial Ecology: Fundamentals and Applications / By Ronald M. Atlas and Richard Bartha – Addison Wesley Longman, Menlo Park ; New York, 1998 (4th Ed.)
2. Current Perspective in Microbial Ecology / By Klug MJ and Reddy CA – American Society for Microbiology, Washington, 1984
3. Ecological Systems and the Environment / By Theodore C. Foin – Houghton Mifflin, London, 1976
4. Biotreatment Systems, Vol. II / By Wise Donald L – Boca Raton : CRC Press, Inc., 1988 (1st Ed.)
5. Wastewater Microbiology / By Gabriel Bitton – Wiley, Florida, 2005 (3rd Ed.)

MBG 404: Genomics and Bioinformatics

(2 Credit)

1. **Genomics:** Genome mapping, genome sequencing, sequence assembly and comparison, genome annotation, comparative genomics, functional genomics, sequence-based approaches, microarray-based approaches. Types and applications of microarray; microarray data visualization techniques and clustering algorithms.
2. **Post-genomics:** Comparative genomics, gene prediction, categories of gene prediction programs, gene prediction in prokaryotes, gene prediction in eukaryotes, promoter and regulatory element prediction, promoter and regulatory elements in prokaryotes, promoter and regulatory elements in eukaryotes, prediction algorithms. Gene expression quantification and functional analysis.
3. **Introductory bioinformatics:** Bioinformatics - definition, goal, history and scope, major areas application and limitations. Major databases, types of databases, pitfalls of biological databases, global bioinformatics centers and servers.
4. **Database searching, sequence alignment and basic sequence analysis:** information retrieval from biological databases, nucleotide database searching: retrieval of specific genes(s) from

database, protein database searching, Pairwise sequence alignment, alignment methods, scoring matrices, statistical significance of sequence alignment, heuristic database searching, Basic Local Alignment Search Tool (BLAST), FASTA, Multiple Sequence Alignment, exhaustive algorithms, heuristic algorithms, profiles and hidden markov models, position-specific scoring matrices, profiles, markov model and hidden markov model, Phylogenetic tree; basics and construction algorithms.

5. **System biology:** Overview, history, aims and associated disciplines, systems biology vs. traditional cell and molecular biology, technologies to study systems at different levels, features of complex systems, data integration, computer modeling and simulations, cellular simulations.
6. **Applications of computational tools for biological data analysis:** Data analysis tools, Commonly used sequence analysis tools, tools for – Restriction mapping analysis, finding repeats and patterns, sequence alignment, finding genes, ORFs and exons, finding transcriptional elements, analyzing protein physicochemical properties of peptides, analyzing protein primary sequences, predicting protein secondary structure, viewing and analyzing protein 3D data, homology modeling, analysis of protein-protein Interaction, designing protein structures.

Books recommended

1. Essential Bioinformatics / By Jin Xiong – Cambridge University press, 2006 (1st Ed.)
2. Bioinformatics for dummies / By Jean michel claverie; Cedric notredame – John Wiley, New York, 2003.
3. Genomes 3 / By T.A. Brown – Garland Science, New York, 2007 (3rd Ed.)
4. Genetics: analysis of Genes to Genomes / By Daniel L. Hartal, Maryellen Ruvolo – Jones and Bartlett Learning, New Delhi, 2012
5. Gene Cloning and DNA Analysis: An Introduction / By T A Brown - Wiley-Blackwell Science, Oxford 2001 (4th Ed.)
6. Biotechnology: Genomics and Bioinformatics / By H J Rehm. and G Reed – Wiley VCH. 2001 (2nd Ed.)
7. Discovering Genomics, Proteomics and Bioinformatics / By Campbell, A. Malcolm; Heyer, Laurie J. - Pearson Education, San Francisco : New Delhi, 2007 (2nd Ed.)

MBG 405: Genetic Engineering

(2 Credit)

1. **Extraction of DNA from different sources:** Preparation of total DNA from bacterial, plant and animal cells; preparation of plasmid and phage DNA
2. **Techniques in Molecular Genetics:** production of recombinant DNA *in vitro*; amplification of recombinant DNA in cloning vector; construction and screening of DNA libraries; molecular analysis of DNA, RNA and protein by blotting techniques; amplification of DNA by PCR; *in vitro* site-specific mutagenesis, chromosome walking.
3. **DNA Manipulative Enzymes:** restriction endonucleases and other nucleases; ligases; polymerases; DNA-modifying enzymes; topoisomerases
4. **Cloning Vectors:** Properties of plasmids; cloning vectors for prokaryotic organisms, plasmid pBR322, bacteriophage M13 and λ ; cosmids; phagemids; charomids; cloning vectors for eukaryotic organisms; yeast episomal plasmid (2 μ m circle); cloning vectors for higher plants and mammalian cells.
5. **Ligation Systems:** blunt and sticky end ligation; putting sticky ends on to a blunt-ended molecule; use of linkers and adaptors.
6. **Introduction of Recombinant DNA into Living Cells:** transformation of bacterial cells and selection of recombinants; introduction of phage DNA into bacterial cell and selection of recombinant phage; transformation of non-bacterial cells.
7. **Sequencing of DNA:** The Sanger-Coulson method; the Maxam-Gilbert method; Pyro-and next generation sequencing.
8. **Analysis of Cloned Gene:** transcript analysis, expression and regulation of a cloned gene; identifying and studying the translation product of cloned gene.

Books Recommended

1. Principle of Gene Manipulation: An Introduction to Genetic Engineering / By R.W. Old and S.B. Primrose – University of California Press, 1980
2. Molecular Biology of the Gene / By Watson, James D.; Baker, Tania A.; Bell, Stephen P.; Gann, Alexander; Levine, Michael; Losick, Richard; Harrison, Stephen C. – Pearson, Boston, 2014 (7th Ed.)
3. Genetic Engineering / By Kingsman, S.M.; Kingsman, A.J. – Blackwell Scientific Publication, London 1988
4. Principles of Genetics / By Snustad, D. Peter; Simmons, Michael J. – Wiley, New Jersey 2010 (5th Ed.)
5. Gene Cloning: An Introduction / By Brown, T. A. – Wiley Blackwell 2016 (7th Ed.)
6. Molecular Cloning: a laboratory manual / By Joseph Sambrook; David W. Russell – Cold Spring Harbor Laboratory, New York, 2001 (3rd Ed.)
7. Current Protocol in Molecular Biology / Edited by Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith – John Wiley and Sons, 2003.

MBG 406: Industrial Microbiology

(2 Credit)

1. **Historical Development and Scope of Industrial Microbiology**; Multidisciplinary nature of Industrial Microbiology; Organization setup in Industrial Microbiology.
2. **Industrial Microorganisms**: Characteristics important in microbes used in Industrial Microbiology and Biotechnology: microorganisms commonly used in Industrial Microbiology and Biotechnology; Screening and Selection of Industrial microorganisms for useful product.
3. **Microbial Production of Biomass**: SCP, Baker's yeast etc.
4. **Microbial production of Industrial Chemicals and food additives**: Organic acids, Amino acids, acetone, butanol, MSG, and Vitamins etc.
5. **Industrial production of antibiotics and microbial enzymes.**
6. **Product development, regulation and safety.**
7. **Visit to food, beverage, pharmaceutical or chemical industries.**

Books Recommended

1. Industrial Microbiology: an introduction / By Waites, Michael J.; Morgan, Neil L.; Rockey, John S.; Higon, Gary – Blackwell Science, Oxford, 2001.
2. Modern Industrial Microbiology and Biotechnology / By Nduka Okafor – Science, New Hampshire, 2007.
3. Prescott and Dunn's Industrial Microbiology / Edited by Gerald Reed – CBS, New Delhi, 1999 (4th Ed.)
4. Industrial Microbiology / By Milier, B. M.; Litsky, W – McGraw-Hill, New York, 1976.
5. Industrial Microbiology / By L.E Casida – Wiley, New York, 1964.

MBG 407: Microbial Biotechnology

(4 Credit)

1. **Historical Development, Scope and Essential Features of Microbial Biotechnology**
2. **Improvement of industrially important microorganisms**: conventional routes to strain improvement; isolation of mutants, auxotrophs, resistant mutants, revertant mutants, use of recombinant systems. Application of system biology and bioinformatics for strain improvement.
3. **Over production of metabolites of industrially important microorganisms**: Derangement or bypassing of regulatory mechanisms for the over-production of primary metabolites, regulation of over-production in secondary metabolites, empirical methods employed to disorganize regulatory mechanisms in secondary metabolic production.
4. **Energy and Biotechnology**: Biomass fuel; fuel-ethanol and methane fermentation; bio-diesel, biofuel cells and bioelectrochemical devices. Genetic manipulation of yeast and bacteria for ethanol production.
5. **Materials and Biotechnology**: Microbial leaching, metal transformation and immobilization; biopolymers (PHA, PHB, PLA etc): production and regulation.

6. **Immobilized Biocatalyst Technology:** principles, benefits, methods of immobilization of enzymes and cells. Application of immobilized biocatalysts.
7. **Biotransformations:** Biocatalysis in organic solvents, enzyme reactors in biotransformation, steroid, aromatic compounds and metals etc.
8. **Chemical Engineering and Biotechnology:** microbial factors and process engineering factors affecting process performance and economics; future development in industrial biotechnological processes
9. **Visit to Biotechnological Research Institutions and Industries**

Books Recommended

1. Biotechnology Principles (Aspects of Microbiology 11) / By John E. Smith – Van Nostrand Reinhold (UK) Co Ltd., 1985
2. Modern Industrial Microbiology and Biotechnology – Nduka Okafor
3. Prescott and Dunn's Industrial Microbiology / Edited by Gerald Reed – CBS, New Delhi, 1999 (4th Ed.)
4. Comprehensive biotechnology: the Principles, applications and regulations of biotechnology in industry, agriculture and medicine / By Moo-Young, Murray – Elsevier, New Delhi, 2004
5. Introduction to biotechnology / By Brown C. M.; Brown C. B.; Campbell I.; Priest F. G – Blackwell, London, 1987
6. Biotechnology: Principles and Applications / By Higgins I.J.; Best D.J.; Jones J. – Oxford U, 1985

MBG 408: Diagnostic Microbiology

(2 Credit)

1. **Specimen collection:** Types of clinical specimen, different approaches to clinical specimen collection, maintenance and laboratory management. Primary Culture - Selection of Culture Media, Specimen Preparation.
2. **Diagnostic Studies:** principles of diagnoses of bacterial, fungal, rickettsial, parasitic, spirochetal, viral and mycoplasmal diseases
3. **Microscopic examination:** application of Microscopy in Diagnostic Microbiology, and Types of Microscopy for Diagnosis of Infectious Diseases.
4. **Traditional approach for Identification:** Bacterial Identification - Principles of Identification, Organism Identification by cultural and biochemical properties; Analysis of Metabolic Profiles; Commercial Identification Systems.
5. **Immunochemical Methods:** Immunochemical Methods Used for diagnostic purpose - Precipitin Tests, Particle Agglutination Method, Immunofluorescent Assays, Enzyme Immunoassays, Haemagglutination Inhibition Assays, and Western Blotting.
6. **Molecular based diagnosis:** Nucleic Acid Hybridization Methods: SB, NB, PCR amplification and Derivations of the PCR Method, Real-Time PCR assays, Non-PCR-Based Amplification Methods, hybrid capture assay, bDNA assay, microarray.
7. **Validation of diagnostic assay**

Books Recommended

1. Bailey and Scott's Diagnostic Microbiology / By Betty A Forbes, Daniel F Sahn and Alice S Weissfeld – Mosby, St. Louise, 2007 (12th Ed.)
2. Textbook of Diagnostic Microbiology / By Connie R Mahon, Donald C. Lehman and George Manuselis Jr. – WB Saunders Co., New York, 2015 (5th Ed.)

MBG 409: Analytical Techniques in Life Sciences

(4 Credit)

1. **Advanced Microscopy:** The Electron and Confocal fluorescent microscopy: Principles and methods; Image analysis and Archiving.
2. **Centrifugation Techniques:** principle of sedimentation; centrifuges and their use; density-gradient centrifugation; ultracentrifuge
3. **Electrophoresis Techniques:** principle; factors affecting electrophoresis; Types and Methods: Native, Gradient, SDS-PAGE, isoelectrophoresis, isoelectric focusing, and 2D gel electrophoresis; amino acid composition, peptide mapping and sequencing.
4. **Protein Characterization:** Biochemical, immunological and molecular assay.

5. **Chromatographic Techniques:** principle of chromatography; column, thin-layer and paper chromatography; adsorption, gas-liquid, ion-exchange, exclusion, affinity and high performance liquid chromatography, fast protein liquid chromatography.
6. **Spectroscopic Techniques:** Visible, ultraviolet and infrared spectrophotometers; spectrofluorimetry; luminometry; NMR and mass spectrometry; X-ray crystallography.
7. **Radioisotope Techniques:** nature, detection and measurement of radioactivity; application of radioisotopes in the biological sciences; safety aspects of the use of radioisotopes
8. **Cell culture techniques:** Preparation and maintenance of cell culture, Primary cell cultures, Continuous cell lines. Cell quantification, Cryopreservation of cells, Determination of cell viability, Assay of cell death: TUNEL assay.
9. **Animal Model:** Inbred strain; Transgenic animal; Knock-in and knock out technology.

Books Recommended

1. Protein Purification: principles and practice / By Robert K. Scopes – Springer-Verlag, New York, 1988 (2nd Ed.)
2. Comprehensive biotechnology: the Principles, applications and regulations of biotechnology in industry, agriculture and medicine / By Moo-Young, Murray – Elsevier, New Delhi, 2004
3. An introduction to practical biochemistry / By David T. Plummer – McGraw-Hill, London, 1978 (2nd Ed.)
4. Basic biochemical methods / By Renee R. Alexander – John Wiley, New York, 1985
5. A Guide to Principle and Techniques of Practical Biochemistry / By Wilson K and Goulding KH (3rd Ed.)

MBG 410: Quality Control of Food and Pharmaceuticals (2 Credit)

1. **Introduction:** importance of quality control of food, fish, beverage and mineral water.
2. **Organization of Quality Control:** the principles, application, organization, problems and techniques of quality control; the future of quality control.
3. **Microbiological Quality Control:** principles and pitfalls; fundamentals of microbiological quality control; chemical and microbiological indicators for quality assurance; standards for monitoring to assess compliance with good practices, Microbial risk assessment.
4. **Sanitation and Inspection:** sanitation and hygiene of processing plant, water in processing and cleaning; waste/effluent treatment packaging; equipment; handling
5. **Quality Assurance:** sampling, testing panel-sensory assessments in quality control; hazard analyses and critical control point (HACCP) systems; identification of potential hazards; monitoring system for critical control point (CCP); corrective actions; verifications.
6. **Food Laws and Regulations:** national and international standards and guidelines.
7. Concept of quality control, quality assurance and total quality control of pharmaceutical industries, sources of variation.
8. Quality control of raw materials, pharmaceutical process, and finished products.
9. Validation of a pharmaceutical process.

Books Recommended

1. Quality control in the food industry / By S. M. Herschdoerfer – Academic press, London, 1984 (2nd Ed.)

MBG 411: Public Health and Epidemiology (2 Credit)

1. **Public Health:** History of public health, Definition of public health, Major disciplines in public health.
2. **Family Health:** Family, Family health, Maternal health, Family planning, Child health.
3. **Health and Development:** The role of health in development, Health and the millennium development goal.
4. **Primary Health Care (PHC):** Introduction and development of PHC, Components of PHC, PHC principles, PHC philosophy and strategy.
5. **Community-Based Health Services:** Introduction, Community responsibility, Community health councils, Community involvement in health (CIH), Team approach in health service.

6. **Introduction to Epidemiology:** Definition of epidemiology, Uses, and Core epidemiologic functions, The epidemiologic approach – defining a case and using counts and rates, Descriptive epidemiology, Analytic Epidemiology, Concepts of disease occurrence, Natural history and spectrum of disease, Chain of infection, Epidemic disease occurrence.
7. **Public Health Surveillance:** Introduction, Purpose and characteristics of public health surveillance, identifying health problems for surveillance, Identifying or collecting data for surveillance, Analyzing and interpreting data, Disseminating data and interpretations, Evaluating and improving surveillance.
8. **Investigating an Outbreak:** Introduction to investigating an outbreak, Steps of an outbreak investigation.
9. **Epidemiological Research Designs:** Observational studies, Experimental or intervention studies, Descriptive epidemiology, Analytic epidemiology, Intervention or experimental studies, randomized and non-randomized trials, controlled trials, clinical trials, field trials and community trials.

Books Recommended

1. Introduction to Public Health / By Mary-Jane Schneider – Jones and Bartlett Learning, 2014 (4th Ed.)
2. Introduction to Public Health / By Mary Louise Fleming and Elizabeth Parker – Churchill Livingstone Australia, 2015 (3rd Ed.)
3. Introduction to Public Health / By Raymond L Goldsteen, Karen Goldsteen, and Terry Dwelle.– Springer Publishing Company, New York. 2015 (2nd Ed.)
4. Principles of Epidemiology in Public Health Practice: An Introduction to Applied Epidemiology and Biostatistics /By Richard Dicker, Fatima Coronado, Denise Koo and Roy Gibson Parrish – CDC, 2012 (3rd Ed.)
5. Dictionary of Epidemiology / By Last JM – Oxford University Press, New York. 2001 (4th Ed.)
6. Good Manufacturing practices for Pharmaceuticals: A Plan for total quality control / By Sidney H. Willing and James R. Stoker – Marcel Dekker Inc., 1996 (4th Ed.)
7. Pharmaceutical process Validation / By Irn R. Berry and Robert A. Nash – CRC Press, 1993 (2nd Ed.)

MBG 412 Practical/Research Project

(8 Credits)

Part A (Virology-II)

1. Detection of viral Ags/Abs from patients' sera by immunological techniques
2. PCR amplification of HBV core and surface genes
3. Detection of viral DNA by PCR amplification and dot-blot hybridisation
4. Use of RPHA method for the detection of viral Ag/Ab
5. Titration of virus using immunofluorescent microscope

Part B (Immunology-II)

1. Detection of antigen and antibody
 - a. by gel immunodiffusion technique
 - b. by radial immunodiffusion technique
 - c. by Crossed immunoelectrophoresis technique
2. SDS-PAGE and immunoblotting of bacterial proteins
3. Complement fixation tests
4. HLA typing

Part C (Environmental Pollution and Bioremediation)

1. Enrichment and isolation of biodegradative microbes from environment
2. Non-culturable state of microorganisms (detection by FA or acridine orange DVC)
3. Detection of indicators and pathogenic microbes in potable water
4. Water purification (*viz.*, flocculation, chlorination, ozonation etc.)

Part D (Genomics and Bioinformatics)

1. Database searching and information retrieval
2. Application of computational tools for – sequence alignment, homology searching, primer design, finding genes, transcriptional elements, analyzing protein-protein Interaction.
3. Phylogenetic tree construction and mutation analysis
4. Structural bioinformatics: DNA/RNA/protein structure prediction, homology modeling, Drug design.
5. Restriction mapping: In vitro and in-silico study.

Part E (Genetic Engineering)

1. DNA digestion by restriction enzymes
2. Ligation of DNA to appropriate vector
3. Study of genetic map

Part F (Industrial Microbiology)

1. Production of ethanol from molasses
2. Production of citric acid from molasses
3. Production of alpha-amylase from starch
4. Production of biogas from domestic wastes
5. Production of acetic acid by *Acetobacteraceti*

Part G (Microbial Biotechnology)

1. Whole cell immobilization by Ca-alginate
2. Determination of specific growth rate, substrate utilization constant and biomass in a steady-state batch culture
3. Pesticide degradation: biodegradation of halogenated pesticide by bacterial dehalogenases

Part H (Diagnostic Microbiology)

1. Determination of blood grouping
2. Coagulation, agglutination and haemagglutination
3. Determination of anti-streptolysin-O (ASO) titre
4. ELISA
5. Direct fluorescent antibody (DFA) detection of microbial pathogens
6. Gene detection and DNA-hybridization analysis in clinical diagnosis
7. Widal test
8. Anti-*Mycobacterium tuberculosis* complex (IgA, IgG and IgM)

Part I (Analytical Techniques in Life Sciences)

1. Thin-layer chromatographic separation of amino acids
2. Separation of sugars by paper chromatography
3. Determination of organic carbon in soil and waste water
4. Estimation of nitrogen in soil and water

Part J (Quality Control of Food and Pharmaceuticals)

1. Sampling: selection, size, collection, labeling and preparation of food samples
2. Subjective or Sensory evaluation: appearance, texture, colour, odour, flavour, taste and additional quality factors; Paired Preference Test (PPT), Ranking Test (RT), Hedonic Tests (HT)
3. Objective or laboratory analysis: Physical and chemical analysis
4. Objective or laboratory analysis: microbiological analysis
5. Demonstration on quality control reporting system

Part K (Public Health and Epidemiology)

1. Demonstration and data analysis on epidemiologic description of a disease
2. Demonstration on health surveillance systems and control of diseases
3. Demonstration on control of personal hygiene in food and health care
4. Demonstration on bioethics in public health

Extra-Departmental Minor Course Offered by the Department of Microbiology for the Other Departments

MBG 200: General Microbiology

(4 Credit)

Theoretical (Marks: 80)

1. **Brief History of the Development of Microbiological sciences**
2. **Microscopy:** basic concepts on microscope and microscopy
3. **Elementary Knowledge on Prokaryotic and Eukaryotic Microorganisms:** structure and function of cell components of prokaryotic and eukaryotic cells
4. **Introduction to Microorganisms:** bacteria, cyanobacteria, fungi, algae, protozoa and archaea
5. **Viruses:** morphology; classification; replication; viroids and prions
6. **Isolation and Identification of Bacteria**
7. **Pure Culture:** techniques of isolation of pure culture and its maintenance
8. **Categorization of Microorganisms:** on the basis of nutritional requirements, morphology, temperature, pH, salinity and hydrostatic pressure
9. **Nutrition of Microorganisms**
10. **Microbiological Culture Media:** culture media, their types, preparation and dispensation.
11. **Microbial Genetics:** mode of gene transmission in bacteria
12. **Techniques of Microbial Control:** control by physical and chemical means
13. **Measurement of Microbial Growth:** growth measurement by direct and indirect methods
14. **Brief Introduction to Aquatic Microbiology**
15. **Infectious Diseases:** Disease causing microbes in fish, bird and animals

Practical (Marks: 20)

1. Handling and use of bright-field microscope
2. Staining techniques: simple staining, negative staining and Gram staining
3. Preparation and examination of bacteriological culture media
4. Transfer and maintenance of microbial pure culture
5. Techniques for isolation of pure cultures: pour plate, spread plate and streak plate methods
6. Enumeration of microbial cells by using improved Neubauer counting chamber
7. Enumeration of microbial cells by standard plate count method
8. Demonstration of antimicrobial activities of antibiotics and antimicrobial agents

Books Recommended

1. Brock Biology of Microorganisms (International Edition)/By Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark – Pearson Prentice Hall, 2012 (12th Ed.)
2. Microbiology/By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw-Hill Book Company, 1986 (5th Ed.)
3. Microbiology: Concepts and Applications/By Michael J. Pelczar JR, E.C.S. Chan and Noel R. Krieg – McGraw Hill Inc., New York, 1993 (1st Ed.)
4. Microbiology: An Introduction/By Gerard J Tortora; Berdell R. Funke; Christine L. Case. – Pearson, Boston, 2016 (12th Ed.)