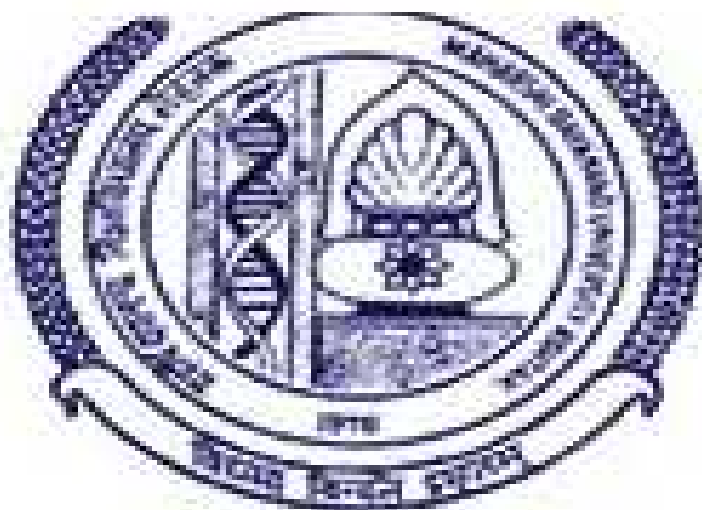


Department of Microbiology

Syllabus

M. Sc. Microbiology



Maharshi Dayanand University
Rohtak 124001

DEPARTMENT OF MICROBIOLOGY

Credit Matrix for M.Sc. Microbiology Program w.e.f. 2016-17

| Semester | Core Paper | Discipline specific elective | Open elective | Foundation course | Total |
|--------------|------------|------------------------------|---------------|-------------------|------------|
| I | 28 | - | - | - | 28 |
| II | 20 | 4 | 3 | 2 | 29 |
| III | 16 | 8 | 3 | - | 27 |
| IV | 28 | - | - | - | 28 |
| TOTAL | 92 | 12 | 6 | 2 | 112 |

REQUIRED CREDITS FOR M.SC MICROBIAL BIOTECHNOLOGY TWO YEAR COURSE:

TOTAL=112

CORE PAPER=92

DISCIPLINE SPECIFIC ELECTIVE=12

OPEN ELECTIVE=6

FOUDATION COURSE=2

INSTRUCTION FOR THE STUDENTS

Course Types:

- **Core papers (C):-** There are Core Courses in every semester. These courses are to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
- **Discipline specific elective (E):-** Soft core is a course which can be chosen from a pool of papers. It will be supportive to the discipline of study & mandatory as per course curriculum.
- **Open Elective (OE):-**Open elective course may be from an unrelated discipline. It is Interdisciplinary/Open Elective & mandatory as per course curriculum.
- **Foundation Course (F):-** The Foundation Course is based upon the content that leads to Knowledge enhancement. It is mandatory as per course curriculum.

Choice Based Credit System

Examination scheme of M.Sc. Microbiology (Semester system) w.e.f. the academic session 2016-17

Note:

| FIRST SEMESTER | | | | | | | | | |
|------------------------|---------------------|---|------------------------------|---|---|----|------------|------------|----------|
| S. No | Course Code | Title | Type | L | T | P | Credits | Marks Th. | Int.Ass. |
| 1 | MBC 101 | Principles of Microbiology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 2 | MBC102 | Principle of Biochemistry | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 3 | MBC103 | Bacterial Diversity | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 4 | MBC104 | Applied Mycology and Phycology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 5 | MBC105 | Biostatistics and Bioinformatics | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 6 | MBC106 | Lab Course I (Based on MBC101 & MBC103) | Core | 0 | 0 | 8 | 4 | 100 | |
| 7 | MBC107 | Lab Course II (Based on MBC102, MBC104 & MBC105) | Core | 0 | 0 | 8 | 4 | 100 | |
| Sub Total | | | | | | | 28 | - | |
| SECOND SEMESTER | | | | | | | | | |
| 8 | MBC 201 | Microbial Physiology and Metabolism | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 9 | MBC 202 | Medical Microbiology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 10 | MBC 203 | Microbial Genetics | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 11 | MBD 204* | Biotechnology | Discipline Specific Elective | 4 | 0 | 0 | 4 | 80 | 20 |
| 12 | or MBD 205* | Genetic Engineering of Microorganisms | Discipline Specific Elective | 4 | 0 | 0 | 4 | 80 | 20 |
| 13 | Open Elective | To be selected from the pool of open electives of university basket | Open Elective | - | - | - | 3 | - | - |
| 14 | Foundation Elective | To be selected from the pool of foundation electives of university basket | Foundation Elective | - | - | - | 2 | - | - |
| 15 | MBC208 | Lab Course III (Based on MBC201, MBC202) | Core | 0 | 0 | 8 | 4 | 100 | |
| 16 | MBC209 | Lab Course IV (Based on MBC203 & MBD204/205) | Core | 0 | 0 | 8 | 4 | 100 | |
| Sub Total | | | | | | | 29 | - | |
| THIRD SEMESTER | | | | | | | | | |
| 17 | MBD 301* | Industrial Microbiology | Discipline Specific Elective | 4 | 0 | 0 | 4 | 80 | 20 |
| 18 | or MBD 302* | Food Microbiology | Discipline Specific Elective | 4 | 0 | 0 | 4 | 80 | 20 |
| 19 | MBC 303 | Immunology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 20 | MBC 304 | Molecular Microbiology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 21 | MBD 305* | Biochemical and Biophysical Techniques | Discipline Specific Elective | 4 | 0 | 0 | 4 | 80 | 20 |
| 22 | or MBD 306* | Downstream Processing | Discipline Specific Elective | 4 | 0 | 0 | 4 | 80 | 20 |
| 23 | Open Elective | To be selected from the pool of open electives of university basket | Open Elective | - | - | - | 3 | - | - |
| 24 | MBC307 | Lab Course V (Based on MBC303 & MBC304) | Core | 0 | 0 | 8 | 4 | 100 | |
| 25 | MBC308 | Lab Course VI (Based on MBD301/ MBD302 & MBD305/ MBD306) | Core | 0 | 0 | 8 | 4 | 100 | |
| Sub Total | | | | | | | 27 | - | |
| FOURTH SEMESTER | | | | | | | | | |
| 26 | MBC 401 | Virology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 27 | MBC 402 | Agriculture and Soil Microbiology | Core | 4 | 0 | 0 | 4 | 80 | 20 |
| 28 | MBC 403 | Dissertation | Core | 0 | 0 | 20 | 20 | 300 | |
| Sub Total | | | | | | | 28 | 500 | |
| G. Total | | | | | | | 112 | - | |

M.Sc. (Microbiology)

(SEMESTER-I)

MBC 101 Principles of Microbiology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

History of development of Microbiology; Development of fields of Microbiology in 20th century; The spontaneous generation controversy; Germ theory of disease; Microbes and fermentation; Physical and Chemical methods of sterilization. Microscopy: Light, Confocal and Electron.

Unit II

Binomial Nomenclature; Haeckel's three kingdom classification; Woese's three kingdom classification systems and their utility – Archaea, Eubacteria, Eukarya; Organization of prokaryotic and eukaryotic cell; Different groups of acellular microorganisms- Viruses, viroids.

Unit III

General features of microorganisms- Bacteria, Algae, Fungi and Protozoa. Classification of bacteria; Bacterial growth and metabolism. Microbes in Extreme Environment – Special features of the thermophilic, methanogenic and halophilic archaea; Photosynthetic bacteria, Cyanobacteria; microbes in other extreme conditions – deep ocean, and space.

Unit IV

Scope of Microbiology- Cycle of matter in nature. Microbial interactions- mutualism, symbiosis, commensalisms, predation, parasitism, amensalism, competition, bioluminescence, biodegradation, biofilms. Cleaning oil spills, microbes in composting, biopesticides, bioremediation, bioleaching, SCP, microbial enzymes and fermented foods. Human diseases and their causative agents. Definition of aeromicrobiology, air-borne pathogens and allergens, Phytopathogenic bacteria: Angular leaf spot of cotton, crown galls, bacterial cankers of citrus. Diseases caused by Phytoplasmas: Aster yellow, citrus stubborn.

Suggested readings:

1. Brock TD., Milestones in Microbiology, Infinity Books.
2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application., Tata McGraw Hill.
3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology, Publisher: MacMillan.
4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: Prentice-Hall , Inc USA.
5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
6. Vandemark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings. Microbiology

M.Sc. (Microbiology)
(SEMESTER-I)
MBC 102 Principles of Biochemistry

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Scope and importance of biochemistry; Fundamental principles governing life; Structure of water; Acid base concept and buffers; pH; Hydrogen bonding; Hydrophobic, Electrostatic and Vander Waal forces. General introduction to physical techniques for determination of structure of biopolymers.

Unit II

Classification, structure and function of carbohydrates; Biomembranes and lipids. Structure and function of amino acids and vitamins. Structure and function of proteins; Types of nucleic acid, their structure and functions.

Unit III

Enzymes: classification, mechanism of action; Factors affecting enzyme action; Immobilized enzymes; Hormones; Thermodynamic principles and biological processes, Bioenergetics.

Unit IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation in Prokaryotes and eukaryotes; recombinant DNA technology

Suggested readings:

1. Mathews C.K., VanHolde K.E. and Ahern K.G., Biochemistry, Benjamin /Cummings.
2. Stryer L., Biochemistry, W.H. Freeman and Company.
3. Devlin's Textbook of Biochemistry with Clinical correlations. John Wiley and Sons Inc.
4. Lehninger A.L., Nelson D.L., Principles of Biochemistry, M.M. Cox. Worth Publishing.
5. Robert K., Murray M.D., Granner D.K., Mayes P.A. and Rodwell V.I. Harper's Biochemistry. McGraw-Hill/Appleton and Lange.
6. Shukla P. and Pletschke, Brett I. (Eds.) (2013) Advances in Enzyme Biotechnology, Springer-Verlag Berlin Heidelberg. ISBN 978-81-322-1094-8 (ebook); ISBN 978-81-322-1093-1 (Softcover)[URL: <http://link.springer.com/book/10.1007%2F978-81-322-1094-8>]

M.Sc. (Microbiology)

(SEMESTER-I)

MBC 103 Bacterial Diversity

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Bacterial Classification- Basis of Bacterial classification; conventional; molecular and recent approaches to polyphasic bacterial taxonomy; evolutionary chronometers; rRNA oligonucleotide sequencing; signature sequences; and protein sequences. Differences between eubacteria and archaeobacteria.

Unit II

Organization of Bacterial Cell- Structure and function of Cell Wall; Cell Membrane; Cytoplasm; Flagella; Endoflagella; Fimbriae; Glycocalyx; Capsule; Endospore; Growth and Nutrition- Cultivation of aerobic; anaerobic and accessing non-cultureable bacteria. Maintenance and preservation of bacterial cultures; Components of media and different types of culture media. Bacterial nutrition: Transport of nutrients; Salient features of bacterial growth curve.

Unit III

Important archaeal groups- According to Brock's 2009 and Bergey's Manual of Systematic Bacteriology. Archaeobacteria: General characteristics; phylogenetic overview; genera belonging to Nanoarchaeota (*Nanoarchaeum*); Crenarchaeota (*Sulfolobus*; *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*; *Methanocaldococcus*); thermophiles (*Thermococcus*; *Pyrococcus*; *Thermoplasma*); and Halophiles (*Halobacterium*; *Halococcus*)]

Unit IV

Eubacteria- Non Proteobacteria and Proteobacteria: Morphology; metabolism; ecological significance and economic importance of following groups:

Gram Negative- Non proteobacteria (*Aquifex*, *Thermotoga*, *Deinococcus*, *Thermus*, *Chlorobium*, *Chloroflexus*, *Chlamydiae*, *Spirochaete*), Alpha proteobacteria (*Rickettsia*, *Coxiella*, *Caulobacter*, *Rhizobium*, *Hyphomicrobium*, *Agrobacterium*), Beta proteobacteria (*Neisseria*, *Burkholderia*, *Thiobacillus*), Gamma proteobacteria (*Enterobacteriaceae* family, Purple sulphur bacteria, *Pseudomonas*, *Vibrio*, *Beggiatoa*, *Methylococcus*, *Haemophilus*), Delta proteobacteria (*Bdellovibrio*, *Myxococcus*), Epsilon proteobacteria (*Helicobacter*, *Campylobacter*).

Gram Positive-Low G+C or Firmicutes (*Mycoplasmas*, *Clostridium*, *Heliobacterium*, *Lactobacillus*, *Lactococcus*, *Staphylococcus*, *Streptococcus*, *Leuconostoc*, *Bacillus*), High G+C or Actinobacteria (*Arthrobacter*, *Bifidobacterium*, *Corynebacterium*, *Frankia*, *Mycobacterium*, *Nocardia*, *Streptomyces*, *Thermomonospora*, *Propionibacterium*, *Cyanobacteria*).

Suggested readings:

1. Salle A.J., Fundamental Principles of Bacteriology.
2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application, Tata McGraw Hill.
3. Stainer RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology. Publisher: MacMillan.
4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: Prentice-Hall, Inc USA.
5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
6. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings. Microbiology

**M.Sc. (Microbiology)
(SEMESTER-I)**

MBC 104 Applied Mycology and Phycology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Introduction of algae: Occurrence and distribution, thallus structure, characteristics, nutrition, classification and reproduction. Introduction of fungi: Occurrence and distribution, somatic structure, hyphal growth, nutrition, heterothallism, sex hormones in fungi, Classification of fungi. Reproduction in fungi: asexual, sexual and parasexual.

Unit II

Study of the different classes with reference to occurrence, somatic structure and life cycle and economic importance representing the following genera: Acrasiomycetes (*Dictyostelium*), Myxomycetes (Endosporus and exosporus), Chytridiomycetes (*Neocallimastix*), Oomycetes (*Phytophthora*), Zygomycetes (*Rhizopus*), Ascomycotina (Hemiascomycetes - *Saccharomyces*, Plectomycetes - *Penicillium*, Pyrenomycetes - *Xylaria*, Discomycetes - *Peziza*), Basidiomycotina (Hymenomycetes *Agaricus*, Teliomycetes - *Puccinia*), Deuteromycetes

Unit III

Algae as pollution indicators, eutrophication agent and role in bioremediation, algae in global warming and environmental sustainability, cyanobacteria and selected microalgae in agriculture as biofertilizer, importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecule.

Unit IV

Lichens and Mycorrhiza: Occurrence, Structure, Types and Importance. Fungi as insect symbionts, fungi as biocontrol agents, attack of fungi on other microorganisms, potential application in Environment, industry, food. Role of fungi in Biodeterioration of wood, paper, textile. Mycotoxins, quorum sensing in fungi

Suggested Readings:

1. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3rd Ed.) Wiley Eastern Ltd., New Del
2. Charlile M. & Watkinson S.C. The Fungi, Publisher: Academic Press.
3. E.Moore –Landeeker: Fundamentals of the fungi, Publisher: Prentice Hall.
4. L. Barsanti, Paolo Gualtieri: Algae: anatomy, biochemistry, and biotechnology
5. Ayhan Demirbas, M. Fatih Demirbas: Algae Energy: Algae as a New Source of Biodiesel (2010)
6. Linda E. Graham, James Graham, James M. Graham: Algae (2009)
7. Burnett J.H., Publisher: Edward, Arnold Crane Russak: Fundamentals of Mycology.

M.Sc. (Microbiology)

(SEMESTER-I)

MBC 105 Biostatistics and Bioinformatics

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Principles and practice of statistical methods in biological research; Samples and Populations; Probability distributions- addition and multiplication theorems, Baye's theorem, Binomial, Poisson, and Normal distribution; Data presentation- Types of data, Methods of data representation.

Unit II

Measures of central tendency- Mean, Median, Mode; Measures of dispersion- Range, Mean deviation and Coefficient of variation, Standard deviation, Standard error; Correlation and regression; Statistical inference- Hypothesis testing, Significance level, Test of significance for large and small samples; Parametric tests; Non parametric tests; Experimental design, Use of biostatistic softwares.

Unit-III

Bioinformatics basics; Application and research; Present global bioinformatics scenario.

Databases- characteristic of bioinformatics databases, navigating databases, information retrieval system and database collaboration; Sequence databases- nucleotide sequence databases, protein sequence database, information retrieval system e.g. Entrez and SRS;

Structure databases- Structure file format, Protein structure database collaboration, PDB, MMDB, FSSP, SCOP, BRENDA, AMENDA and FRENDA, Pathway databases e.g. CAZy.

Unit-IV

Tools- Need for tools, data mining tools, data submission tools e.g. nucleotide submission tools and protein sequence submission tools; Data analysis tools- nucleotide sequence analysis and protein sequence analysis tools e.g. BLAST & FASTA. Prediction tools- multiple nucleotide alignment, phylogenetic tree, gene prediction, protein structure & function prediction. Modeling tools: 2D and 3D protein modeling.

Suggested Readings:

1. Casella G. and Berger R.L., Statistical Inference (The Wadsworth and Brooks/Cole Statistics/Probability Series) b, Brooks/Cole Pub Company.
2. Grant G.R., Ewens W.J. ,Statistical Methods in Bioinformatics: An Introduction. Springer Verlag.
3. Jagota A. Data Analysis and Classification for Bioinformatics, Bioinformatics By The Bay Press.
4. Spiegel M.R., Schiller J.J., Srinivasan R. A. , A. Srinivasan Schaum's Outline of Probability and Statistics. McGraw-Hill Trade.

**M.Sc. (Microbiology)
(SEMESTER-I)**

**MBC106: Lab Course I (Based on MBC101 & MBC103)
(Microbiology; Bacterial Diversity)**

Time: 3 hrs

Marks: 100

Microbiology: Microscopic examination of bacteria, actinomycetes, algae, fungi and protozoa; Differential staining methods; Study of shape and arrangement of bacterial cells; Preparation of microbiological media; Sterilization: principles & operations; Preparation of specific media for isolation of bacteria, actinomycetes and fungi from natural sources; Sampling and quantification of microorganisms in air, soil and water; Isolation of thermophiles from compost.

Bacterial Diversity: Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food). Staining of bacteria and actinomycetes, Use of selective media, Enrichment culture technique – isolation of asymbiotic nitrogen fixing bacteria; Isolation of symbiotic nitrogen fixing bacteria from nodules, Isolation of antibiotic producing microorganisms. Morphological, physiological and biochemical characterization of isolated bacterial cultures.

**M.Sc. (Microbiology)
(SEMESTER-I)**

MBC107: Lab Course II (Based on MBC102, MBC104 & MBC105)

(Mycology and Phycology; Biochemistry; Biostatistics & Bioinformatics)

Time: 3 hrs

Marks: 100

Mycology and Phycology: Isolation and identification of fungi from different environmental samples, Study the nutritional requirement of fungi, Cultivation of fungi in submerged and solid state fermentation, Production of enzymes, organic acids and other metabolites by fungi, Collection and study of basidiomycetous fungi, Study and culturing of yeasts, study yeast dimorphism, Isolation and identification of algae from different habitats, Culturing of algae under lab conditions, Study hydrogen and bioethanol production by algae, Algae as a source of SCP, study pollution control by algae.

Biochemistry: Preparation of standard and buffer solutions; Use of simple techniques in laboratory (spectrophotometry-verification of Beer's law, relation between O.D. and percentage transmission; Centrifugation) Estimation of sugars, Estimation of Proteins by Lowry's method; Estimation of DNA and RNA by diphenylamine and orcinol methods; Determination of enzyme activity and study of enzyme kinetics; Separation of biomolecules by electrophoresis.

Biostatistics and Bioinformatics: Software handling, BLAST: finding scores and E-values; Sequence alignment, nucleotide restriction-site determination; Dendrogram making (both rooted and unrooted); gene prediction, primer and oligos development using different softwares; Retrieval of gene, finding specific gene from whole-genome sequence; Developing protein structure using Ras Mol; Finding hydrophobicity in protein sequence e.g. Kite & Doolittle; Developing a vector map using a software.

Suggested Readings:

1. Benson H.J. Microbiology Applications – (A Laboratory Manual in General Microbiology), Wm C Brown Publishers.
2. Cappuccino J.G. and Sherman N., A Laboratory Manual, Addison-Wesley.
3. Work T.S. and Work R.H.E., Laboratory Techniques in Biochemistry and Molecular Biology. Elsevier Science
4. Becker J.M., Coldwell G.A. & Zachgo E.A., Biotechnology – a Laboratory Course, Academic Press.

**M.Sc. (Microbiology)
(SEMESTER-II)**

MBC 201 Microbial Physiology and Metabolism

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Nutritional Categories of microorganisms based on carbon and energy sources, Metabolite Transport- Passive and facilitated, Primary and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron. Microbial Growth- Definition balanced and unbalanced growth, growth curve, the mathematics of growth, Generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve. Types of Culture media, Isolation of pure cultures.

Unit II

Brief account of photosynthetic and accessory pigments - chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins; Carbohydrates- anabolism. Autotrophy, oxygenic, anoxygenic photosynthesis – autotrophic generation of ATP; fixation of CO₂, Calvin cycle, C₃, C₄ pathway. Chemolithotrophy: sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis, luminescence.

Unit III

Respiratory metabolism, Embden-Mayer Hoff pathway, EntnerDoudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis, Pasteur effect; Fermentation of carbohydrates, homo and heterolactic fermentations.

Unit IV

Biosynthesis of peptidoglycan, polysaccharides, major amino acids, polyamines, Lipids, Nucleotides: Purines and Pyrimidines; Assimilation of nitrogen; Dormancy and germination; Microbial Differentiation, sporulation and morphogenesis, Cell division cycle in *E.coli* and yeast.

Suggested Readings

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009

M.Sc. (Microbiology)
(SEMESTER-II)
MBC 202 Medical Microbiology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Early discovery of pathogenic microorganisms, development of medical microbiology as a discipline, normal microbial flora of the human body and their importance. Host parasite relationships: Definitions: infection, invasion, pathogen, pathogenicity, toxigenicity, virulence, carrier, types of carriers, opportunistic infections. Role of aggressins, depolymerizing enzymes, organotrophism. Transmission and spread of infection. Hospital acquired infections and their management

Unit II

Principle of different diagnostic tests (ELISA, Immunofluorescence, agglutination based tests). Modern approaches for diagnosis of infectious diseases: Basic concepts of gene probes, dot hybridization and PCR assays. Mechanism of action of various chemotherapeutic agents (antibacterial, antifungal and antiviral). Principle of drug resistance. Various methods of drug susceptibility testing, passive and active prophylactic measures

Unit III

Study of important bacterial diseases caused by the following genera with reference to causative agent, pathogenesis, symptoms, transmission, control measures, epidemiology and diagnosis. *Bacillus anthracis*, *Staphylococcus*, *E.coli*, *Salmonella typhi*, *Shigella dysenteriae*, *Vibrio cholerae*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*, *Corynebacterium diphtheriae*, *Treponema palladium*. Emerging and reemerging bacterial pathogens.

Unit IV

Study of important viral diseases with reference to causative agent, pathogenesis, symptoms, transmission, control measures, epidemiology and diagnosis. Hepatitis, influenza, rabies, polio, chicken pox, herpes, dengue fever, AIDS. and viral cancers. An overview of emerging and reemerging viral diseases: Ebola, SARS, Hanta and Chikungunya. Introduction to protozoan, fungal and helminthes diseases: Malaria, Giardiasis, & leishmaniasis; Superficial, subcutaneous, systemic and opportunistic mycoses.

Suggested Readings

1. Ananthanarayanan R. and C.K. Jayaram Panicker Orient Longman Text of Microbiology, 1997.
2. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection. Vol.2: Practical Medical Microbiology Churchill Livingstone, 1996.
3. Shanson D.C., Wright PSG, Microbiology in Clinical Practice., 1982.
4. Baron EJ, Peterson LR and Finegold SM Mosby, Bailey and Scott's Diagnostic Microbiology, 1990.
5. Smith, C.G.C. "Epidemiology and Infections" (1976): Medowfief Press Ltd., Shildon, England.

M.Sc. (Microbiology)
(SEMESTER-II)
MBC 203 Microbial Genetics

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Mendel's work on transmission of traits; Genetic Variation; Molecular basis of Genetic Information; Mitosis and Meiosis; Linkage and crossing over; Molecular mechanism of crossing over; Recombination and recombination frequency

Unit II

Mutations-Induced versus Spontaneous mutations, Suppressor mutations, Molecular basis of Mutations, mutant enrichment; Complementation tests; recombination tests and gene replacements; Cloning genes by complementation and marker rescue; DNA repair mechanisms, Mutation and Microbial evolution.

Unit III

Molecular mechanism of gene transfer by conjugation. Regulation of gene transfer by conjugation. Mapping bacterial genomes using Hfr strains. Transfer systems in gram positive bacteria. Ti plasmid and application; Transformation and transduction; Natural transformation and competence. Molecular basis of natural transformation; Regulation of competence in *B.subtilis*. Artificially induced competence. Generalized versus specialized transduction, Mapping bacterial genes by transduction; Tetrad analysis in fungi, Positive and negative gene regulation and attenuation, using the *lac*, *gal*, *trp* and *ara* operons, with emphasis on recent advances.

Unit IV

Lytic cycle of T4 and T7 bacteriophages, Regulation of expression of genes in phage T4 and T7. Replication and packaging of filamentous phages M13. Benzer's experiments with the rII genes of phage T4 to construct phage genetic linkage maps. Lambda phage – Lytic and lysogenic cycles. Other lysogenic phages – P1 and Φ x174. Transposons and gene regulation. Yeast Ty-1 transposon. Phase variation in bacteria, Transplantation (Synthetic genome).

Suggested Readings

1. Snyder L. and Chapness W. Molecular Genetics of Bacteria 2007.
2. Birge EA. 1981. Bacterial and Bacteriophage Genetics. Springer Verlag.
3. Gardner JE, Simmons MJ & Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.
4. Lewin B. 1999. Gene. Vols. VI, IX. John Wiley & Sons.
5. Maloy A & Friedfelder D. 1994. Microbial Genetics. Narosa.
6. Scaife J, Leach D & Galizzi A 1985. Genetics of Bacteria. Academic Press.
7. William Hayes 1981. Genetics of Bacteria. Academic Press.
8. Microbial Genetics. Maloy et. al. 1994. Jones & Bartlett Publishers.
9. Dale J.W., Molecular genetics of bacteria. 1994. John Wiley & Sons.
10. Streips & Yasbin. Modern microbial genetics. 1991. Niley. Ltd.

M.Sc. (Microbiology)
(SEMESTER-II)
MBD 204* Biotechnology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

History and scope of biotechnology; application of biotechnology in pharmaceutical- Human Insulin, Human Growth Hormone, Human Blood Clotting Factors, Gene Therapy, Plant and animal cell culture techniques and their applications

Unit II

Recombinant DNA Technology; DNA modifying enzymes- Cutting and joining DNA molecules; Cloning strategies; Plasmid and phage vectors, Cosmids, phagemid and other advanced vectors. Expression of recombinant proteins using bacterial, animal and plant vectors; Genomic and cDNA; Designing and labeling of Primers and probes; Nucleic acid blotting.

Unit III

Agrobacterium-mediated transformation; Particle bombardment; Gene transfer in animals -direct microinjection, nuclear transfer technology; Bacteria- calcium chloride transformation; Electroporation; Genome transplantation in bacteria; Vaccine development; Embryo transfer technology; Immobilized enzymes;

Unit IV

Introduction to Intellectual Property Rights: Patentable subject matter and patent types, Patent requirements: technical specifications, novelty, and non-obviousness, Rights of patent holder, Patent protection for biological materials, biotechnological inventions, software, algorithms and methods, The patent application, WIPO and WTO/TRIPS.Regulatory Procedures: Good laboratory practice, Good manufacturing practice.

Suggested Readings:

1. Brown T.A., Gene Cloning and DNA Analysis ,Blackwell Publishing.
2. Dale J.W. & von Schantz M. 2002. From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons.
- Gupta P.K. 2008. Biotechnology and Genomics. Rastogi Publications.

M.Sc. (Microbiology)
(SEMESTER-II)
MBD205* Genetic Engineering of Microorganisms

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit-I

Value addition in industrially important microorganisms using recombinant DNA technology; Basic techniques involved; Essential enzymes used in recombinant DNA technology; Cloning vectors; Cloning strategies. Cloning and selection of individual genes, gene libraries: cDNA and genomic libraries; Design of vectors for the over expression of recombinant proteins: selection of suitable promoter sequences, fusion protein tags, protease cleavage sites and enzymes, inducible expression systems; organelle specific expression of cloned gene.

Unit-II

Mutagenesis and directed evolution of microbes. Different expression systems- Cloning in bacteria other than *E. coli*; cloning in *Saccharomyces cerevisiae*; cloning in GRAS microorganism; Gene regulation- RNA interference: antisense RNA technology. Bioethics, Biosafety and IPR issues.

Unit-III

PCR methods, PCR optimization, PCR cloning, real-time PCR, and PCR application in diagnostics; DNA sequencing methods. *In vitro* mutagenesis of cloned gene; Proteomics- basic concept and importance. Metagenome: DNA isolation from diverse sources, library formation, screening of clones: functional screening, sequence based and high-throughput screening.

Unit-IV

Nucleic acid sequences as diagnostic tools: Detection of sequences at the gross level, single nucleotide polymorphisms (SNPs), importance of SNPs, forensic applications of VNTRs. New drugs and new therapies for genetic diseases: recombinant proteins for therapeutic use. Recombinant bacterial vaccines, Recombinant viruses as vaccines, Plants as edible vaccines, DNA vaccines, selecting targets for new antimicrobial agents, *In vivo* expression technology (IVET), and signature-tagged mutagenesis.

Suggested Reading:

1. Nicholl D. S. T. 2008. An Introduction to Genetic Engineering, Cambridge University Press.
2. Glick BR, Pasternak JJ. 2003. Molecular Biotechnology. ASM Press Washington D.C.
3. Old and Primrose 2008. Principles of Gene Manipulation. Blackwell Scientific Publication.
4. Brown T.A. 2010. Gene Cloning. Blackwell Publishing.

M.Sc. (Microbiology)

(SEMESTER-II)

Open elective: Microbial World: Diversity and applications

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit – I

Systematics&Biodiversity:Classification and nomenclature of microorganism.Salient featuresof different groups: Acellularmicroorganisms (Viruses,Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) in reference to their distribution and occurrence, morphology, mode ofreproduction and economic importance.

Unit – II

Characteristics of extremophiles:Thermophiles, Methanophiles, Alkalophiles, Acidophiles, Halophiles and Barophiles: Classification, habitats, ecological aspects andapplications.

Unit – III

Microbiological techniques:Preparation of culture media, Pure culture isolation; cultivation,maintenance and preservation/stocking of pure cultures; cultivation of anaerobicbacteria, and accessing non-culturable bacteria. Physical and Chemical methods for the control of microorganisms

Unit – IV

Scope of Microbiology:Role of microorganisms in Food industry, Pharmaceutical industry, Production ofIndustrial enzymes, Agriculture: bio-fertilizers, bio-pesticides. Environment:bioremediation, bioleaching

Suggested readings:

1. Brock TD., Milestones in Microbiology, Infinity Books.
2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application.,Tata McGraw Hill.
3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology, Publisher: MacMillan.
4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: Prentice-Hall , Inc USA.
5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
6. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings. Microbiology

M.Sc. (Microbiology)
(SEMESTER-II)
Foundation Course: Communication Skills

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

UNIT I

Basics of Technical Communication: Introduction and Structure of Communication, The Process of Communication, Language as a Tool of Communication, Levels of communication, The Flow of Communication, Communication Networks, The Importance of Technical Communication.

UNIT II

Oral/visual Communication: Active Listening, Speech Structure, The Art of Delivery, Effective Presentation Strategies, Use of audio visual Aids, ICTs, Handling the Audience, Body Language, Conducting Meetings, Interviews, Group Discussion, Negotiation, Small Talk.

UNIT III

Reports: Informal and Formal: Characteristics of a Report, Types of Reports, The Importance of Reports, Formats, Prewriting, Structure of Reports, Writing the Report, Revising, Editing and Proofreading.
Writing Journal Articles: Word choice and Syntax style, Number use, References, Plagiarism.

UNIT IV

Technical Proposal and Thesis Writing Methodology

M.Sc. (Microbiology)
(SEMESTER-II)

MBC 208: Lab Course III (Based on MBC201, MBC202)
(Microbial Physiology and Development; Medical Microbiology)

Time: 3 hrs

Max marks: 100

Microbial Physiology and Metabolism: Determination of viable number of Bacterial cells in a given sample. Determination of bacterial growth by turbidity measurements (Bacterial growth curve). To study the microscopic measurements. To study the types of growth (synchronous, diauxic, batch). Effects of incubation temperature on the growth of microorganisms. To study the lethal effect of temperature. Effects of different pH on the growth of microorganisms. To study the bacterial growth under aerobic, microaerophilic and anaerobic conditions. Effect of salt concentration on the growth of microorganisms. Preparation of selective and differential media for the growth of microorganisms. Fermentation of different carbohydrates. Morphological, Physiological and Biochemical tests of selected bacterial cultures.

Medical Microbiology: Fixation of smears for microscopy by different methods, Different staining techniques, Simple staining, Negative staining, Gram's staining, Ziehl-Neelsen method for AFB, Fluorochrome staining, Leishman's stain, Giemsa's staining, Preparation of culture media: Simple tissue culture methods for growing different pathogenic microorganisms, Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi. Anaerobic culture method-Principles of automated methods for diagnostic microbiology, Isolation of pure cultures and preservation techniques, Drug susceptibility testing by various methods.

M.Sc. (Microbiology)
(SEMESTER-II)

MBC 209: Lab course IV (Based on MBC203, MBD204/MBD205)

(Microbial Genetics; Biotechnology)

Time: 3 hrs

Max marks: 100

Microbial Genetics: Inactivation of microorganisms by different mutagens. Production, isolation and characterization of mutants. Determination of mutation rate. Isolation, characterization and curing of plasmids. Preparation of competent cells, Transformation of *E.coli*. using plasmid DNA Transfer of plasmid by conjugation, electroporation. Tetrad and random spore analysis

Biotechnology: Biotechnology: Isolation of plasmid and genomic DNA, Plasmid as cloning vector, Restriction enzymes and their role in biotechnology, Ligation method, Expression of recombinant proteins using bacterial, animal and plant vectors, Agrobacterium-mediated gene transformation, Preparation of competent cells and transformation, Study microbial cell and enzyme immobilization. Designing of gene specific primers.

Genetic engineering of microorganisms: Estimation of protein, RNA and DNA; SDS-PAGE of proteins; DNA isolation; Purification; polymerase chain reaction; DNA restriction analysis; RFLP and RAPD analysis; Transformation of *E. coli* using plasmid DNA, Genetic improvement of Isolated industrially important microorganisms for production of microbial metabolites. Comparative studies of ethanol production using different substrates, Production of antibiotics and microbial enzymes.

Suggested readings:

1. Cappuccino J.G. and Sherman N., A Laboratory Manual, Addison-Wesley.
2. Becker J.M., Coldwell G.A. & Zachgo E.A., Biotechnology – a Laboratory Course, Academic Press.
3. Sambrook J., Fritsch T. & Maniatis T. 2001.

M.Sc. (Microbiology)
(SEMESTER-III)
MBD 301* Industrial Microbiology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Introduction and scope of industrial microbiology; Biology of industrially important microbes (metabolic pathways and control mechanisms); Isolation and selection of industrially important microorganisms; Genetic improvement of microbes; Preservation and maintenance of microbial cultures.

Unit II

Microbial substrate- Media formulation, Optimization of media; Cell growth kinetics: Kinetics of substrate utilization, biomass production and product formation in batch, fed batch and continuous cultivations; Kinetics of death of microorganisms

Unit III

Types of fermentation processes; Solid state, Static and submerged fermentations; Design of laboratory bioreactor; Types of Bioreactor: Stirred tank reactor, bubble column reactor, Airlift reactor, Packed bed reactor, Fluidized bed reactors; Scale-up principles; Instrumentation and control of bioprocesses; Downstream process; Fermentation economics.

Unit IV

Types of microbial products; Production of Biomass: Baker's Yeast, Mushroom, Single cell proteins, Biopesticides and biofertilizers; Production of primary metabolites: Ethanol; organic acids; Amino acids; Vitamins; Bioplastics; Industrial enzymes. Production of secondary metabolites: Antibiotics (penicillin, cephalosporins, streptomycin, etc), Pigments, Microbial transformation, Production of metabolites of non-microbial origin eg Insulin, Interlukin, Cytokines etc using rDNA technology. Designer microbes using synthetic genome.

Suggested readings:

1. Stanbury P. F., A. Whitaker, S. J. Hall. Principles of Fermentation Technology Publisher: Butterworth-Heinemann
2. Shuler M.L. and F. Kargi: Bioprocess Engineering Basic Concepts by Publisher Prentice Hall.
3. Vogel H.C., C.L. Todaro, C.C. Todaro: Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment by Publisher: Noyes Data Corporation/ Noyes Publications.
4. W. Crueger and A.Crueger: Biotechnology. A Textbook of Industrial Microbiology, Publisher : Sinauer Associates.
5. Prescott and Dunn's Industrial Microbiology.Publisher: Gerald Reed: Books.
6. Casida L. E. J. R: Industrial Microbiology by Publisher: New Age (1968)
7. Shukla P. and Pletschke, Brett I. (Eds.) (2013) Advances in Enzyme Biotechnology, Springer-Verlag Berlin Heidelberg. ISBN 978-81-322-1094-8 (ebook); ISBN 978-81-322-1093-1 (Softcover)
[URL: <http://link.springer.com/book/10.1007%2F978-81-322-1094-8>]

M.Sc. (Microbiology)
(SEMESTER-III)
MBD 302* Food Microbiology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Food and Microorganisms- Historical developments, Microorganisms important in food molds, yeast and bacteria- general characteristics, classification and importance; Factors affecting growth of microorganisms-Hydrogen ion conc., water activity, oxidation reduction potential, nutrient content, inhibitory substances and biological structure.

Unit II

Spoilage and preservation of foods- Microorganisms associated with plants, soil, animals, water and air; Spoilage and preservation of different foods-Vegetables, fruits, cereals, sugar and its products, milk and its products, meat and meat products, poultry, fish and sea foods. Food preservation techniques.

Unit III

Food fermentation- Production methods of bread, cheese, fermented vegetables and dairy products, vinegar, wine, oriental fermented foods on industrial scale, microbes as a single cell protein (quorn and pruteen), Mushrooms: nutritive values of mushrooms, Edible and poisonous Mushrooms.

Unit IV

Food borne infections and intoxications-Bacterial and nonbacterial infection with examples of infective and toxic types, *Brucella*, *Bacillus*, *Clostridium*, *Escherichia*, *Salmonella*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia*, fungi (*Aspergillus*, *Penicillium*) viruses (*Hepatitis*, *Poliomyelitis*) and nematodes and emerging food-borne pathogens; Foodborne outbreaks, laboratory testing procedures and preventive measures, food sanitation in manufacture and retail trade.

Suggested Readings

1. Adams, M. R. and Moss, M. O. (2005) Food Microbiology (Second edition). Royal Society of Chemistry Publication, Cambridge.
2. Jay, J.M. (2008) Modern Food Microbiology (Sixth Edition). Aspen Publishers, Inc. Gaithersburg, Maryland.
3. Ray, B. (2005) Fundamental food microbiology (Third edition). CRC Press, New York, Washington D.C.
4. Frazier, W. C. and Westhoff, D. C. (2007) Food Microbiology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
5. George J Banwart. 1989. Basic Food Microbiology. AVI publication.
6. Pepler HJ & Perlman D. 1979. Microbial Technology. 2nd Ed. Academic Press.

M.Sc. (Microbiology)

(SEMESTER-III)

MBC 303 Immunology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Historical background, Innate and adaptive immunity; Cells and organs involved in immune system; Antigens and Antibodies- Properties and types; Haptens and Adjuvants. Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype). Genesis of antibody variability. Concept of tolerance, immunopotential and immunosuppression.

Unit II

Immunological principles of various reactions and techniques: Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA, western blotting, immunofluorescence, RIST, RAST, MLR, flow cytometry and fluorescence, and immunoelectron microscopy; Hybridoma technology, monoclonal antibodies and abzymes; Antibody engineering.

Unit III

Organization of Major histocompatibility complex (mice and humans). Structure and cellular distribution of HLA antigens, antigen processing and presentation, cytosolic and endocytic pathways. Complement system: Components of the complement activation, classical, alternative and lectin pathways; Complement activation

Unit IV

Types and mechanism of hypersensitive reactions; Autoimmunity - theories, mechanism and diseases with their diagnosis; tumor immunology - tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors - detection of tumor markers – α foetal proteins, carcinoembryonic antigen etc Immunodeficiency disorders: Animal models of primary immunodeficiency (nude mouse and SCID mouse). Specific impaired functions in lymphoid lineage (SCID, DiGeorge syndrome), myeloid lineage (CGD and Chediak, Higashi Syndrome).

Suggested Readings :

1. Clark, W.R., "The Experimental Foundations of Modern Immunology (1991): John Wiley and Sons. Inc.
2. Roitt, I.M: Essential Immunology (1995): Blackwell Scientific Publications, Oxford.
3. Roth, J.A. (1985): Virulence Mechanism of Bacterial Pathogens. American Society for Microbiology, Washington D.C.
4. Stiehm F. (1980), "Immunological Disorders in Infants and Children" (1980): W.B. Saunders & Co., Philadelphia.
5. Stites, D.P. Stobo, J.D. Feudenberg, H.H., Wells J.V.: Basic and Clinical Immunology, (1984): Lange Medical Publications., Los Altos., California.
6. Todd, I.R. (1990): Lecture Notes in Immunology, Blackwell Scientific Publications Ltd., Oxford.

M.Sc. (Microbiology)
(SEMESTER-III)
MBC 304 Molecular Microbiology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

History of molecular biology; Nucleic acids as hereditary material; Structure of nucleic acid; Secondary and tertiary structure of nucleic acids; Types of RNA- rRNA, tRNA and mRNA; structure of ribosomes; Nucleases; Restriction and modification; Nucleic acid sequencing; DNA replication and DNA polymerases of *E.coli*.

Unit II

Transcription; RNA polymerases; Types of promoters; Reverse transcriptase and RNA replicase; Genetic code; Translation; Gene regulation at transcriptional and translational level; Operon- positive and negative control; Attenuation; Molecular mechanism of mutation; Mechanism of DNA repair.

Unit III

Molecular organization of eukaryotic genome- Structure of genomes, Chromatin; Types of DNA polymerases, DNA replication; Types of RNA polymerases- Transcription, Structure of primary transcript; Ribozyme, RNA processing and alternate splicing; Structure of ribosomes and translation in eukaryotes; Development and differentiation; Molecular evolution.

Unit IV

Cell division cycle- Check points in cell cycle; apoptosis and its pathways; Oncogenes-Retroviruses, Tumor suppressor p53, Telomere shortening, Ras oncogenes; Oncoproteins and gene expression; Genetic instability and cancer.

Suggested readings:

1. Lewin, B. Gene X, Oxford University Press.
2. Brown, T.A. Genomes, John Wiley and Sons Inc.
3. Brown. T.A. Molecular Biology LabFax, Bios Scientific Ltd.Oxford.
4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. Molecular Biology of the Cell, Garland Publishing.
5. Watson, J.D, Weiner, A.M and. Hopkins, N.H Molecular Biology of the Gene Addison-Wesley Publishing.
6. Lodish, H., Berk, A., Zipursky, S., Matsudaira, P., Baltimore, D. and Darnell, J.E Molecular Cell Biology, W.H. Freeman and Company.

M.Sc. (Microbiology)
(SEMESTER-III)
MBD 305* Biochemical and Biophysical Techniques

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Basics of microscopy, Electron Microscopy. Differential centrifugation and purification by density gradient centrifugation. Spectrophotometry: Principles and applications UV, Visible, Mass Spectrometry, MALDI-TOF, Atomic Absorption Spectrometer, X- Ray spectroscopy

Unit II

Isolation and purification of microbial protein, Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method, Polyacrylamide gel electrophoresis (PAGE), native and SDS, PAGE, 2D,PAGE, capillary electrophoresis, IEF.

Unit III

Chromatographic methods of separation, Principles and applications of Paper, Thin layer chromatography, Gas, Liquid chromatography, HPLC and FPLC; PCR & its types

Unit IV

Antisense and RNAi technology, Protein and DNA sequencing techniques, Maxam–Gilbert sequencing, Chain termination methods, Next generation sequencing technologies, Pyrosequencing. Genomic and cDNA library preparation, RFLP, RAPD and AFLP techniques. Autoradiography, applications of radioactive tracers in biology, FACS.

Suggested Readings :

1. Clark JM. 1977. Experimental Biochemistry. 2nd Ed. WH Freeman. Sawhney SK & Singh R. 2000. Introductory Practical Biochemistry. 2nd Ed. Narosa.
2. Willard M, Merritt LL & Dean JA.1981. Instrumental Methods of Analysis. 4th Ed. Van Nostrand.
3. William BL & Wilson K. 1975. Principles and Techniques of Practical Biochemistry. Edward Arnold.
4. Wilson K, Walker J & Walker JM. 2005. Principles and Techniques of Practical Biochemistry. Cambridge Univ. Press.
5. Kolowick NP & Kaplan NP. Methods in Enzymology. Academic Press (Series).
6. Plummer DT. 1998. An Introduction to Practical Biochemistry. 3rd Ed. Tata McGraw Hill.
7. Rickwood D. (Ed.). 1984. Practical Approaches in Biochemistry. 2nd Ed. IRL Press, Washington DC.
8. Wilson K & Goulding KH. 1992. A Biologist's Guide to Principles and Techniques of Practical Biochemistry. 3rd Ed. Cambridge Univ. Press.
9. Wilson K & Walker J. 2000. Principles and Techniques of Practical Biochemistry. 5th Ed. Cambridge Univ. Press.

M.Sc. (Microbiology)
(SEMESTER-III)
MBD 306* Downstream processing

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Role and importance of downstream processing in biotechnological processes. An overview of bioseparation; Problems and requirements of bioproduct purification; Characteristics of biological mixtures; Downstream process economics.

UNIT-II

Physico-chemical basis of bio-separation processes. Removal of particulate matter; biomass; and insolubles: flocculation and sedimentation; centrifugation and filtration methods; Cell disruption methods; Enrichment Operations: precipitation methods (with salts; organic solvents; and polymers; extractive separations; aqueous two-phase extraction; supercritical extraction); adsorption method.

Unit III

Membrane separations: Membrane based separation theory; Types of membranes; Types of membrane processes (Dialysis; Ultrafiltration; microfiltration and Reverse Osmosis). Chromatographic separations: Paper; TLC; Adsorption; Ion exchange; Gel filtration; affinity chromatographic separation processes; GC; HPLC; FPLC; Electrophoretic separation.

Unit IV

Final product polishing and Case studies: Products polishing: Crystallization and drying; Purification of cephalosporin; aspartic acid; Recombinant Streptokinase; Monoclonal antibodies; Tissue plasminogen activator; Taq polymerase; Insulin.

Suggested readings:

1. Chromatographic and Membrane Processes in Biotechnology by C.A. Costa and J.S. Cabral. Publisher: Kluwer Academic Publishers
2. Bioseparations: Downstream Processing for Biotechnology by P.A. Belter et al. Publisher: John Wiley and Sons Inc
3. Bioseparations by P.A. Belter, E.L. Cussler and W.S. Hu. Publisher: John Wiley and Sons Inc.
4. Biochemical Engineering Fundamentals by J.E. Bailey and D.F. Ollis. Publisher: McGraw-Hill.
5. Downstream Processing by J.P. Hamel, J.B. Hunter and S.K. Sikdar. Publisher: American Chemical Society.

M.Sc. (Microbiology)

(SEMESTER-III)

Open Elective: Microbial Technology for Entrepreneurship

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Commercial Microbial Products; Introduction to bioprocess development- upstream development, downstream process, Preservation and improvement of industrially important microorganisms, Strain development by mutagenesis, protoplast fusion and Genetic engineering.

Unit II

Raw materials and media formulation for microbial culture; batch, fed batch and continuous mode of bioprocess, Types of Bioreactors and their applications: Stirred tank bioreactor & Specialized bioreactors.

Unit III

Downstream process, Choice of bioprocess plant location; Methods of estimation of Capital Cost and Operational costs of bioprocess plant, Good Lab Practices (GLP) and Good Manufacturing Practices (GMP).

Unit IV

Introduction to Bioentrepreneurship; Factors necessary for Entrepreneurship; Attributes in an Entrepreneur; Market Assessments; Managing Technology transfer and Intellectual property in biotechnology in India, Licensing of Biotechnological invention, Funding agencies in India, Basics of Patents- Types of patents; Filing of a patent application.

Suggested readings:

1. Handbook of Bioentrepreneurship by **Patzelt**, Holger, **Brenner**, Thomas (Eds.) Publisher:
2. SpringerBiotechnology. A Textbook of Industrial Microbiology, by W. Crueger and A. Crueger. Publisher: Sinauer Associates.
3. Industrial microbiology by G. Reed, Publishers: CBS
4. Bioprocess Engineering Principles by P. Doran. Publisher: Academic Press.
5. Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher: McGraw Hill.

M.Sc. (Microbiology)
(SEMESTER-III)

MBC308: Lab Course V (Based on MBC303 and MBC304)
(Immunology and Molecular Microbiology Lab)

Time: 3 hrs

Max marks: 100

Immunology: Determine total leucocyte count (TLC) of a given blood sample, To perform differential leucocyte count (DLC) of the blood sample, Separation of serum from the blood sample, Identification of human blood groups – ABO and Rh factor, Immunodiffusion by Ouchterlony method, Immunoelectrophoresis with a given antigen, antibody system, Dot- ELISA; Demonstration of Western blotting.

Molecular Microbiology: To study agarose gel electrophoresis of genomic DNA, To study genomic DNA isolation from bacteria and fungi, DNA isolation from humus rich soil samples and diversity study using 16s rDNA primers, To study restriction profile of isolated DNA and plasmid samples, Isolation of plasmids from *E.coli DH5a* cells, Isolation of DNA fragments which carry promoter sequence, Synthesis and codon modification of bacterial hemoglobin gene, Agrobacterium mediated gene transformation studies in fungi, To prepare chemically competent cells of *E. coli DH5a* and determine their transformation efficiency, To amplify the laccase/phytase/xylanase gene by Polymerase Chain Reaction, To clone the laccase/cellulase/phytase/xylanase amplicon into the TA cloning vector pGEM-T.

M.Sc. (Microbiology)
(SEMESTER-III)

MBC309: Lab Course VI (Based on MBD301/MBD302 and MBD304/MBD305)
(Industrial Microbiology/Food Microbiology & Biochemical & Biophysical Techniques/ Downstream Processing)

Time: 3 hrs

Max marks: 100

Industrial Microbiology: Isolation of industrially important microorganism from different sources using specific substrates; Design and Preparation of Media for Bioprocesses; Growth curve studies of bacteria/Yeasts in batch culture and calculation of maximum specific growth rate; To study the various methods of biomass measurement; Production of ethanol from sucrose by yeast; Determination of yield coefficient and Monod's constant and metabolic quotient of *E.coli* culture on glucose.; To study the design of fermenter and its working; Production of citric acid using sucrose and molasses; Production of extracellular enzymes ; Ethanol production using immobilized yeast culture.

Food Microbiology: Isolation of Lactobacilli from curd or milk sample, Detection of number of bacteria in milk by SPC, Determination of quality of milk sample by methylene blue reductase test (MBRT), Microbiological examination of different food samples; Production of Sauerkraut by microorganisms, Determination of antibacterial activity of lactic acid bacteria using agar well diffusion method. Statutory, recommended and supplementary tests for microbiological analysis of various foods: Baby foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers and water.

Biochemical & Biophysical Techniques: Determination of absorption maxima of some important chemicals from their absorption spectra, estimation of biomolecule using spectrophotometer, Separation of carbohydrates and amino acids by paper chromatography, Separation of lipids by thin layer and column chromatography, Separation of proteins by ion exchange and gel filtration chromatography, Electrophoretic techniques to separate proteins and nucleic acids, Preparation of stock solutions and buffers; Standard curves of BSA; Estimation of protein, RNA and DNA; SDS-PAGE of proteins; Polymerase chain reaction; RAPD analysis; DNA restriction analysis.

Downstream Processing: Separation of microbial biomass from culture medium, Isolation of cell bound and intracellular product, Cell lysis and different methods, Isolation and purification of a protein by salt and solvent precipitation, Study the application of dialysis in downstream processing of a product, Product recovery and purification by different chromatography techniques such as gel filtration, ion exchange and other chromatography, Determination of molecular mass of a protein using SDS-PAGE and gel filtration chromatography, Ultrafiltration and its application in purification.

Suggested readings:

1. Cappuccino J.G. and Sherman N., A Laboratory Manual, Addison-Wesley.

2. Work T.S. and Work R.H.E., Laboratory Techniques in Biochemistry and Molecular Biology. Elsevier Science
3. Becker J.M., Coldwell G.A. & Zachgo E.A., Biotechnology – a Laboratory Course, Academic Press.
4. Sambrook J., Fritsch T. & Maniatis T. 2001.

M.Sc. (Microbiology)

(SEMESTER-IV)

MBC 401 Virology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit I

Brief outline on discovery of viruses, nomenclature and classification of viruses; Viral genome, their types and structures; virus related agents; Viral cultivation, assay and diagnosis; primary & secondary cell cultures; Assay of viruses, physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy), Infectivity assay (plaque method, end point method) – Infectivity assay of plant viruses. Haemagglutination & HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmunoassays.

Unit II

Bacterial Viruses-Bacteriophage structural organization; life cycle: lytic and lysogenic cycle, application of bacteriophages; brief details on M13, Mu, T7, T4, Lambda and P1. Viruses of cyanobacteria, algae, fungi.

Unit III

Plant Viruses- Structure and life cycle of plant viruses. Propagation, purification, characterization, identification and symptoms of diseases caused by plant viruses like TMV, Cauliflower Mosaic Virus, Gemini virus and Potato Virus X, Transmission of plant viruses, Some common viral diseases: Papaya ring spot, rice tungro, Potato spindle tuber, coconut cadang cadang.

Unit IV

Animal Viruses- Structure and lifecycle of animal viruses. Replicative strategies employed by DNA and RNA viruses. Epidemiology, pathogenicity, diagnosis, prevention and treatment of Picorna, Orthomyxo, Paramyxo, Rhabdo, Pox, Herpes, Adeno, Hepatitis, HIV and other Oncogenic viruses; Viral vaccines (conventional vaccines, genetic recombinant vaccines, newer generation vaccines including DNA Vaccines with examples) interferons, and antiviral drugs.

Suggested Readings

1. Morag C and Timbury M.C (1994) Medical virology-X Edition. Churchill Livingstone, London.
2. Dimmock NJ, Primrose SB (1994). Introduction to Modern Virology, IV Edition, Blackwell Scientific Publications, Oxford
3. Conrat HF, Kimball PC and Levy JA (1994) Virology-III Edition Prentice Hall, Englewood cliff, New Jersey.
4. Mathews, RE., (1992) Functionals of Plant virology, Academic press, San Diego.
5. Topley and Wilson's (1995) Text Book on Principles of Bacteriology,
6. Virology and Immunology. Edward Arnold, London.

M.Sc. (Microbiology)

(SEMESTER-IV)

MBC 402 Agriculture and Soil Microbiology

Time: 3hrs

Marks: 80

Note: The question paper will consist of 9 questions. Students will have to attempt 5 questions in total - Question no. 1 will comprise of short answer questions covering the entire syllabus and will be compulsory. Two questions to be set from each Unit and students will have to attempt one from each Unit.

Unit – I

Development of soil microbiology; Distribution of microorganisms in soil; Quantitative and qualitative microflora of soils; general description of soil, types of soil, soil profile, Role of microorganisms in soil fertility; Influence of soil and environmental factors on microflora: moisture, pH, temperature, organic matter; Distribution of microorganisms in manure and composts; Influence of soil amendments on soil microflora.

Unit – II

Microorganisms in soil processes: biogeochemical cycles, Nitrogen fixation: symbiotic, non symbiotic, associative symbiotic and endophytic organisms, process of nitrogen fixation, Molecular biology of Nitrogen fixation; Microbial transformation of phosphorus, iron, sulphur and micronutrients in soil; phosphorus solubilization by phosphobacteria; sulphur; iron bacteria and their importance.

Unit – III

Interrelationships between plants and microorganisms -Rhizosphere concept - quantitative and qualitative studies – R : S ratio - Rhizoplane -spermosphere - phyllosphere microorganisms - their importance in plant growth. PGPR (plant growth promoting rhizobacteria), siderophores and antimicrobials, microbial interactions.

Unit –IV

Biofertilizer: Mass cultivation of microbial inoculants; green manuring; Microbial products and plant health; Microbial Pesticides: development and their significance; Source Organisms: Bacteria-*Bacillus thuringiensis*, Bt based commercial products, other Bacilli producing pesticides.

Suggested readings:

1. Subba Rao, N.S. (1999). Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Alexander, M. (1985). Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi.
3. Rangaswami. G. 1979. Recent advances in biological nitrogen fixation. Oxford and IBH. New Delhi.
4. Subba Rao, N.S. (1995) .Soil Micro organisms and plant growth, Oxford and IBH publishing Co. Pvt. Ltd.

M.Sc. (Microbiology)
(SEMESTER-IV)
MBC 403 Dissertation in Microbiology

Marks : 300

Note:

The Dissertation will be based upon research and actual bench work. It will be carried out IVth Semester, but review of literature etc. will be initiated in the IIIrd Semester in order to give maximum time for working of students. The dissertation will be submitted at the end of semester and will be evaluated by external and internal examiners. The dissertation topics and date of submission will be decided by Departmental committee.

