Department of Microbiology

Syllabus & Scheme of Examination

M. Sc. Microbiology

Maharshi Dayanand University
Rohtak 124001

Program Specific Outcomes:

Students who graduate with MSc. (Microbiology) will,

PSO1: Have significant knowledge on various aspects of Microbiology.

PSO2: Be well-trained in laboratory techniques of basic microbiology, especially with regard to isolation, characterization and biochemical identification of the microbes.

PSO3: Have deeper insights into the various aspects of immunology and medical microbiology and grasp the scientific basis for the diagnosis, prevention, control and treatment of infectious disease.

PSO4: Develop good understanding of the role of microorganisms in industry, health and environment.

PSO5: Acquire technical skills especially in regard to industrially important metabolites and their production.

PSO6: Be enabled to plan and execute experiments as well as to analyze & interpret data for a research problem.

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 MICROBIOLOGY 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:-** 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:-** 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**:-Open elective course may be from an unrelated discipline. It is Interdisciplinary/Open Elective & mandatory as per course curriculum.
- **Foundation Course**:- 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

S. No	Course Code	Title	Type	L	T	P	Credits	Marks Th.	Marks Int. Ass.
FIRST SEMESTER									
1	16MCB21C1	Principles of Microbiology	Core	4	0	0	4	80	20
2	16MCB21C2	Principles of Biochemistry	Core	4	0	0	4	80	20
3	16MCB21C3	Bacterial Diversity	Core	4	0	0	4	80	20
4	16MCB21C4	Applied Mycology and Phycology	Core	4	0	0	4	80	20
5	16MCB21C5	Biostatistics and Bioinformatics	Core	4	0	0	4	80	20
6	16MCB21CL1	Lab Course I (Based on16MCB21C1, C2)	Core	0	0	8	4	100	
7	16MCB21CL2	Lab Course II (Based on 16MCB21C3, C4, C5)	Core	0	0	8	4	100	
	Sub Total						**28**	-	
SECOND SEMESTER									
8	16MCB22C1	Microbial Physiology and Metabolism	Core	4	0	0	4	80	20
9	16MCB22C2	Medical Microbiology	Core	4	0	0	4	80	20
10	16MCB22C3	Microbial Genetics	Core	4	0	0	4	80	20
11	16MCB22D1	Biotechnology	Discipline Specific Elective	4	0	0	4	80	20
12	or 16MCB22D2	or Genetic Engineering of Microorganisms		4	0	0	4	80	20
13	-----	To be selected from the pool of open electives of university basket	Open Elective	-	-	-	3	-	-
14	-------	To be selected from the pool of foundation electives of university basket	Foundation Elective	2	0	0	2	-	-
15	16MCB22CL1	Lab Course III (Based on16MCB22C1, C2)	Core	0	0	8	4	100	
16	16MCB22CL2	Lab Course IV(based on16MCB21C3 & D1/D2)	Core	0	0	8	4	100	
	Sub Total						**29**	-	
THIRD SEMESTER									
17	17MBB23DA1 or	Industrial Microbiology	Discipline Specific Elective	4	0	0	4	80	20
18	17MBB23DA2	or Food Microbiology		4	0	0	4	80	20
19	17MBB23C1	Immunology	Core	4	0	0	4	80	20
20	17MBB23C2	Molecular Microbiology	Core	4	0	0	4	80	20
21	17MBB23DB1 or	Biochemical and Biophysical Techniques	Discipline Specific Elective	4	0	0	4	80	20
22	17MBB23DB2	or Downstream Processing		4	0	0	4	80	20
23	----	To be selected from the pool of open electives of university basket	Open Elective	-	-	-	3	-	-
24	17MBB23CL	Lab Course V (Based on17MBB23C1, C2)	Core	0	0	8	4	100	
25	17MBB23DL	Lab Course VI(Based on17MBB23 DA1/DA2 & DB1/DB2)	Core	0	0	8	4	100	
	Sub Total						**27**	-	
FOURTH SEMESTER									
26	17MBB24C1	Virology	Core	4	0	0	4	80	20
27	17MBB24C2	Agriculture and Soil Microbiology	Core	4	0	0	4	80	20
28	17MBB24C3	Dissertation	Core	0	0	20	20	300	
	Sub Total						**28**		
	G. Total						**112**	-	

L- Lecture, T- Tutorial, P- Practical

M.Sc. (Microbiology)

(SEMESTER-I)

16MCB21C1 - Principles of Microbiology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes:
On the completion of this course students will be able to learn the following:

CO1: To learn about the basic instrumentation in microbiology and historical details about the development of microbiology
CO2: To learn the characteristics of bacteria, fungi and viruses and details about classification of these
CO3: To understand about the scope of microbiology in different diversified areas

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, viriods.

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. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their nature and Importance: Benjamin Cummings.Microbiology

M.Sc. (Microbiology)

(SEMESTER-I)
16MCB21C2 - Principles of Biochemistry

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes:
On the completion of this course students will be able to learn the following:
CO1: The significance of physical forces and chemical reactions in the biomolecules.
CO2: The basic understanding about the universal biochemical reaction in a basic unit of life i.e., Cell.
CO3: They will also understand the reason of metabolic disorders at molecular level.
Structure and functions of different biomolecules (e.g. DNA, RNA, Proteins & Carbohydrates)

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)
16MCB21C3 - Bacterial Diversity

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes
On completion of the course, students are able to understand
CO1: Basis of Bacterial classification: conventional; molecular and recent approaches
CO2: The Organization of Bacterial Cell
CO3: Cultivation, maintenance and preservation of bacterial cultures.
CO4: General characteristics of Archaebacteria and their phylogenetic overview
CO5: Overview of Bacterial Diversity: Morphology, Metabolism, Ecological Significance and Economic importance

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 archaebacteria.

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

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, PropionibacteriumCyanobacteria*).

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. 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-I)
16MCB21C4 - Applied Mycology and Phycology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes
On completion of the course, students are able to understand
CO1: General characteristics and ultrastructure of algae and fungi
CO2: Basis of classification of fungi and algae and life cycles of important members belonging to different class of fungi.
CO3: Applied aspects of fungi and algae especially in industry, agriculture and environment
CO4: Interaction of fungi and algae with other organisms
CO5: Role of algae and fungi in different spheres

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 (*Dictyosteluim*), Myxomycetes (Endosporus and exosporus), Chytridiomycetes (*Neocallimastrix*), Oomycetes (*Phytopthora*), 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. Myxotoxins, 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 –Landeekeer: 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)
16MCB21C5 - Biostatistics and Bioinformatics

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes

Students who complete this course will be able to:
CO1: The roles biostatistics and general principles of biostatistics
CO2: Learn the practical importance of key concepts from probability and inference, inductive versus deductive reasoning, including related biostatistics techniques
CO3: Explain Experimental design and use of biostatistics softwares
CO4: Learn about the bioinformatics databases, perform text- and sequence-based searches.
CO5: Understand multiple sequence alignment, sequence alignment the secondary and tertiary structures of protein sequences.

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)
16MCB21CL1 - Lab Course I (Based on 16MCB21C1 & C2)

Total Marks: 100
Time: 4 hours

Course Outcomes

On completion of the course, students are able to:

CO1: Prepare media and isolate and cultivate microbes from various sources
CO2: Learn the microscopic characteristic features of microbes.
CO3: Isolate and quantify various groups of microorganisms
CO4: Use of selective and differential media
CO5: Morphological, physiological and biochemical characterization of isolated bacterial cultures

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)
16MCB21CL2 -: Lab Course II (Based on 16MCB21C3, C4 & C5)

Total Marks: 100
Time: 4 hours

Course Outcomes

On completion of the course, students are able to learn:

CO1: Isolation and identification of important algae and fungi from various sources
CO2: Counting of fungal spores and production of important metabolites from fungi
CO3: The basis and working of simple techniques in laboratory like spectrophotometry, centrifugation etc.
CO4: Estimation of various macromolecules like sugar, protein , DNA and RNA
CO5: Software handling, BLAST, Sequence alignment, nucleotide restriction-site determination primer design
CO6: Phylogenetic analysis using construction of Dendrogram, Developing protein structure, a vector map

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 (spectrophotometery-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 an; E-values; Sequence alignment, nucleotide restriction-site determination,; Dendrogram making (both rooted and unrooted); gene prediction, primer and oligos development using different softwares; Retrival of gene, finding specific gene from whole-genome sequence; Developing protein structure using Ras Mol; Finding hydrophobicity in protein sequence e.g. Kitte & 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)
16MCB22C1 - Microbial Physiology and Metabolism

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes
On completion of the course, students are able to understand
CO1: Microbial nutrition and Process of membrane transport
CO2: Types of culture media and isolation of pure cultures and Salient features of microbial growth
CO3: Photosynthetic and Respiratory metabolism, Concept of Chemolithotrophy
CO4: Metabolic pathways of Biomolecules and assimilation of nitrogen
CO5: Microbial Differentiation, Dormancy and Cell division cycle in *E. coli* and yeast

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 microorganismsbased 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 CO_2, 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)
16MCB22C2 - Medical Microbiology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes
On completion of the course, students are able to understand
CO1: Basis of host-parasite relationship
CO2: Principals of different diagnostic tests and Modern approaches for diagnosis of infectious diseases
CO3: Few important bacterial, viral and fungal diseases with regard to causative agent, pathogenesis, symptoms, transmission, control measures, epidemiology and diagnosis
CO4: Various means of prevention, treatment and management of infectious diseases
CO5: Mechanism of chemotherapeutic agents and principle of drug resistance

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 generawith reference to causative agent, pathogenesis, symptoms, transmission, control measures, epidemiology and diagnosis. *Bacillus anthracis, Staphylococcus, E.coli, Salmonella typhii, Shigella dysenteriae, Vibrio cholerae, Haemophilus influenzae, Mycobacterium tuberculosis*, *Corynebacterium diptheriae*, *Treponema palladium*. Emerging and reemerging bacterial pathogens.

Unit IV
Study of important viral diseases wih 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)
16MCB22C3 - Microbial Genetics

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes:
On the completion of this course students will be able to learn the following:
CO1: The basic principles involved in heredity.
CO2: The mechanisms of genetic manipulation of bacteria, fungi and viruses.
CO3: The principles involved in the microbial evolution

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 ofGenetic 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 bacteriphages, 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 Φx174. 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 & Sones.
10. Streips & Yasbin. Modern microbial genetics. 1991. Niley. Ltd.

M.Sc. (Microbiology)

(SEMESTER-II)
16MCB22D1 - Biotechnology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes
On completion of the course, students are able to understand
CO1: Various aspects of biotechnology and its applications in different fields
CO2: The strategies to clone genes and to produce recombinant protein
CO3: The application of biotechnology for product development.
CO4: Intellectual property rights, regulatory procedures and good manufacturing practices

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)
16MCB22D2 - Genetic Engineering of Microorganisms

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes
On completion of the course, students are able to understand
CO1: Different tools and techniques of gene manipulation
CO2: The techniques to clone and express the genes
CO3: Learn to produce recombinant protein
CO4: The application of molecular biology for product development.

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)
16MCB22CL -: Lab Course III (Based on 16MCB22C1 & C2)

Total Marks: 100
Time: 4 hours

Course outcomes
CO1: On the completion of this course students will be able to learn the following:
CO2: Various techniques for the determination of microbial growth and biomass and to study the effect of different factors on growth
CO3: Isolations of nitrogen fixating bacteria and studying their activity
CO4: Isolation of medically important organisms and their characterization
CO5: Differential staining procedures important in medical microbiology
CO6: Drug susceptibility testing by various methods

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. Ferrmentation 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, Fluorchrome 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)
16MCB22DL -: Lab course IV (Based on 16MCB22C3 & D1/D2)

Total Marks: 100
Time: 4 hours

Course Outcomes

CO1: Isolation of whole genomic DNA, their restriction digestion and purification
CO2: Isolation, characterization and curing of plasmids
CO3: Preparation of competent cells and transformation
CO4: Microbial cell immobilization
CO5: Whole cell protein profiling
CO6: Tetrad and random spore analysis

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, Transformationof*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)
17MCB23DA1 - Industrial Microbiology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes

CO1: This course is designed to develop an understanding of an applied aspect of microbiology in Industry.
CO2: The course gives insight into the development of bioprocess strategy including different phases of the bioprocess: Upstream development, production and downstream.
CO3: The course focuses on techniques used in industry for production of microbial products thus it enables the students to enter the industry with essential knowledge of Microbiology and fermentation technology.

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)
17MCB23DA2 - Food Microbiology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcome
On the completion of the course students are able to understand

CO1: Characterization, classification and importance of different types of microorganisms involved in food microbiology and the factors affecting growth of microorganisms.

CO2: Microbial analysis of milk using methylene blue reductase test.

CO3: Causes of food spoilage, Spoilage of fruit, Vegetables, Dairy product and meat products and study of different types of microorganisms associated with spoiled food.

CO4: Food Preservation techniques –Chemical Method, Physical method and biological methods

CO5: Production of sauerkraut, wine, citric acid etc. and cultivation of mushrooms

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 (quron 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*, *Poliomylitis*) 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. Peppler HJ & Perlman D.1979. Microbial Technology. 2nd Ed. Academic Press.

M.Sc. (Microbiology)

(SEMESTER-III)

17MCB23C1 - Immunology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course outcomes

On the completion of this course students will be able to learn the following:

CO1: Properties of immune cells and immune system

CO2: Principles of various immunological techniques and their application in diagnoses of diseases

CO3: Various concepts related to types of antigen and antibodies and their role

CO4: Development of cell mediated and humoral immune response

CO5: Mechanism of hypersensitive, autoimmune, immunoderficiency reactions and immune response to tumors

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, immunopotentiation 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., Clifomia.
6. Todd, I.R. (1990): Lecture Notes in Immunology, Blackwell Scientific Publications Ltd., Oxford.

M.Sc. (Microbiology)
(SEMESTER-III)
17MCB23C2 - Molecular Microbiology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course outcomes
On the completion of this course students will be able to learn the following:

CO1: Exiting history of the discovery and structure of DNA molecule
CO2: Mechanism of transfer of genetic materials
CO3: Three key event of central dogma: 1. Replication, 2. Transcription and 3. Translation
CO4: Cell cycle and cancer causing genes/molecules e.g. mutations

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)

17MCB23DB1 - Biochemical and Biophysical Techniques

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course outcomes

On completion of the course, students are able to understand:

CO1: Microscopy (light microscopy and electron microscopy),

CO2: Gene cloning and PCR allow students to make a large amount of DNA from only a small fragment. They also understand how do these technologies work?

CO3: Students learn the Purification of microbial protein and their electrophoretic separation and characterization.

CO4: They will learn the analytical techniques like Gas-liquid; HPLC and FPLC.

CO5: They also will understand about DNA sequencing technique, antisense and RNAi technology

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. 30

M.Sc. (Microbiology)
(SEMESTER-III)
17MCB23DB2 - Downstream processing

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course objectives:
On the completion of this course students will be able to learn the following:
CO1: Basic principles involved in the purification of metabolites of commercial importance.
CO1: Improvements in the downstream processing of existing commercial products like insulin, Taq polymerase etc.
CO1: Different cost-cutting strategies in the downstream processing of products.

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.

MSc. (Microbiology)
(SEMESTER-III)
17MCB23CL - Lab Course V (Based on 17MCB23C1 & C2)

Total Marks: 100
Time: 4 hours

Course Outcomes

On completion of the course, students are able to learn:

CO1: Determination of total and differential leucocyte count, Identification of human blood groups

CO2: Various immunodiagnostic techniques like agglutination, precipitation and ELISA

CO3: Molecular diagnostics by PCR and blotting

CO4: Genomic DNA isolation from bacteria, fungi and humus rich soil samples and diversity study using 16s rDNA primers

CO5: To clone the laccase/cellulase/phytase/xylanase amplicon into the TA cloning vector pGEM-T. Restriction profile of isolated DNA and plasmid samples

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, Immuno-electrophoresis 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 DH5α* 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* DH5α 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)
17MCB23DL - Lab Course VI (Based on 17MCB23DA1/DA2 & DB1/DB2)

Total Marks: 100
Time: 4 hours

Course Outcomes

On completion of the course, students are able to learn:

CO1: Isolation of industrially important microorganism from different sources

CO2: Growth curve studies of bacteria/Yeasts in batch culture and calculation of growth and biomass Determination of yield coefficient and Monod's constant and metabolic quotient of E.coli culture

CO3: Design of fermenter and its working

CO4: Microbiological examination of different food samples

CO5: Determination of quality of milk sample by methylene blue reductase test (MBRT) and SPC method and Isolation of Lactobacilli from curd or milk sample

CO6: 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

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)
17MCB24C1 - Virology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course outcomes
On the completion of this course students will be able to learn the following:
CO1: Nomenclature, structure and classification of viruses
CO2: Various concepts related to cultivation, assay and diagnosis of viruses
CO3: Structural organization of bacteriophage, cyanopahages and viruses of algae and fungi, Life cycle of bacteriophages
CO4: Structure and life cycle of plant viruses. Propagation, purification, characterization, identification and symptoms of important diseases caused by plant viruses
CO5: Structure and lifecycle of animal viruses. Epidemiology, pathogenicity, diagnosis, prevention and treatment of important viral diseases of human. Various vaccines aginst viral diseases and anti-viral therapy

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; briefdetails on M13,Mu,T7,T4, Lamda and P1. Viruses of cyanabacteria, 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 MosaicVirus ,Gemini virus and Potato Virus X, Transmission of plant viruses,Some common Viriod diseases:Papaya ring spot, rice tungro, Potato spindle tuber, coconut cadang cadang.

Unit IV
AnimalViruses- Structure and lifecycle of animal viruses. Replicative strategies employed by DNA and RNA viruses. Epidemiology, pathogenicity, diagnosis, prevention and treatment of Picorna,Ortho myxo, 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. ChurchillLivingstone, London.
2. Dimmock NJ, Primrose SB (1994). Introduction to Modern Virology, IVEdition, Blackwell Scientific Publications, Oxford
3. Conrat HF, Kimball PC and Levy JA (1994) Virology-Ill Edition PrenticeHall, Englewood cliff, New Jersey.
4. Mathews, RE.,(1992) Functionals of Plant virology, Academic press, SanDiego.
5. Topley and Wilson's (1995) Text Book on Principles of Bacteriology,
6. Virology and Immunology. Edward Arnold, London.

M.Sc. (Microbiology)

(SEMESTER-IV)
17MCB24C2 - Agriculture and Soil Microbiology

Theory Marks: 80
Internal assessment: 20
Time: 3 hours

Course Outcomes:

On the completion of the course students are able to understand

CO1: Process of nitrogen fixation and its molecular biology.
CO2: Microbial transformation of phosphorus, iron, sulphur and other micronutrients in soil.
CO3: The role of plant growth promoting rhizobacteria
CO4: Different types of plant-microbes interactions.
CO5: Study of biopesticides and biofertilizers.

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)
17MCB24C3 - Dissertation in Microbiology

Total Marks : 300

Course Outcomes

On completion of the course, students will acquire

CO1: In-depth knowledge of the current research and development work in microbiology
CO2: The ability to plan and carry out tasks in given framework of thesis
CO3: The capability to clearly present and discuss the planned work/task both in written and spoken English.
CO4: Capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.

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.