Department of Microbiology

Syllabus

M.Sc Microbiology

Maharshi Dayanand University
Rohtak 124001

Choice Based Credit System

Examination scheme of M.Sc. Microbiology (Semester system) w.e.f. the academic session 2011-12

S. No	Course No.	Title	Type	L	T	P	Credits	Marks	
								Th.	Int. Ass.
FIRST SEMESTER									
1.	MB-101	Principles of Microbiology	CP	4	0	0	4	80	20
2.	MB-102	Principles of Biochemistry	CP	4	0	0	4	80	20
3.	MB-103	Food Microbiology	CP	4	0	0	4	80	20
4.	MB-104	Applied Mycology and Phycology	CP	4	0	0	4	80	20
5.	MB-105	Biotechnology	PE	4	0	0	4	80	20
6.	P1–MB	Microbiology, Biochemistry, Food Microbiology and Mycology & Phycology Lab			0	5x4 =20	10	150	
Sub Total							**30**	**650**	
SECOND SEMESTER									
1.	MB-201	Bacterial Diversity	CP	4	0	0	4	80	20
2.	MB-202	Microbial Physiology and Development	CP	4	0	0	4	80	20
3.	MB-203	Industrial Microbiology	CP	4	0	0	4	80	20
4.	MB-204	Medical Microbiology	CP	4	0	0	4	80	20
5.	MB-205	Microbial Energetics	PE	4	0	0	4	80	20
6.	MB-206	Seminar			0	0	1		50
7.	P2–MB	Bacterial Diversity, Microbial Energetics, Microbial Physiology, Industrial and Medical Microbiology Lab		0	0	5x4 =20	10	150	
Sub Total							**31**	**700**	
THIRD SEMESTER									
1.	MB-301	Molecular Microbiology	CP	4	0	0	4	80	20
2.	MB-302	Microbial Genetics	CP	4	0	0	4	80	20
3.	MB-303	Environmental Microbiology	CP	4	0	0	4	80	20
4.	MB-304	Immunology	CP	4	0	0	4	80	20
5.	MB-305	Biochemical and Biophysical Techniques	PE	4	0	0	4	80	20
6.	MB-306	Communication Skill development	OE	2	0	0	2	50	00
7.	MB-307	Seminar			0	0	1		50
8.	MB-308	Self study paper*		0	0	0	1	Qualifying	
9.	P3-MB	Molecular Microbiology, Microbial Genetics, Immunology, Biochemical & Biophysical Techniques and Environmental Microbiology Lab		0	0	5x4 =20	10	150	
Sub Total							**34**	**750**	
FOURTH SEMESTER									
1.	MB-401	Biostatistics and Bioinformatics	CP	4	1	0	5	80	20
2.	MB-402	Virology	CP	4	1	0	5	80	20
3.	MB-500	Dissertation		0	0	0	20	300	
Sub Total							**30**	**500**	
G. Total							**125**	**2600**	

***Grading: Excellent, Very Good, Good, Satisfactory, Unsatisfactory**

M.Sc. (Microbiology)

(SEMESTER-I)

MB-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 20^{th} century; The spontaneous generation controversy; Germ theory of disease; Microbes and fermentation; Physical and Chemical methods of sterilization.

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; Cell Division Cycle in *E. coli* and Yeast; 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. 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)

MB-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.

M.Sc. (Microbiology)

(SEMESTER-I)

MB-103 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

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

Unit III

Food fermentation- Production methods of bread, cheese, fermented vegetables and dairy products, vinegar, wine, oriental fermented foods on industrial scale. Spoilage and defects of fermented food products. Food preservation-General principles of food preservation; preservation of vegetables, fruits, cereals, sugar and its products, milk and its products, meat and meat products, poultry, fish and sea foods.

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, viruses, 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-I)
MB-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, physiological specialization in fungi, fungi and ecosystem; saprophytic parasitic, mutualistic and symbiotic relationship with plants and animals. 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 (*Alternaria)*

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- biofertilizer and algalization, importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecule.

Unit IV

Lichens: ascolichens, basidiolichens, deuterolichens, Mycorrhiza: ecto-, endo-, ectendo-, VAM, Fungi as insect symbionts, fungi as biocontrol agents, attack of fungi on other microorganisms, potential application in Agriculture, 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)
MB-105 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; Use of plants , animals and microbial systems for production of useful products; Microbial biotechnology; Plant and animal cell and tissue 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; Designer Microbes; Diagnostic tools; therapies for genetic diseases (gene therapy); monoclonal antibodies and hybridoma technology, Vaccine development; Embryo transfer technology; Immobilized enzymes; application of biotechnology in pharmaceutical, food and chemical industry.

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, Regulations for recombinant DNA research and manufacturing process, Regulations for clinical trials, Rules for import and export of biological materials, Bio-safety and Bioethics

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.
3. Gupta P.K. 2008. Biotechnology and Genomics. Rastogi Publications.

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

P1–MB: Microbiology, Biochemistry, Food Microbiology, Biotechnology and Mycology & Phycology Lab

Time: 6 hrs **M. Marks: 150**

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.

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.

Production of amylases and proteases by fungi; Plant tissue culture media preparation, cell and explant culture, regeneration and transformation, Isolation of genomic and plasmid DNA; Gel electrophoresis techniques; Restriction enzyme digestion, ligation, transformation and screening of transformants; PCR.

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.

Mycology & 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.

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.

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.
   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. Molecular Cloning – a Laboratory Manual. 2nd Ed. Cold Spring Harbour Laboratory Press.

M.Sc. (Microbiology)
(SEMESTER-II)
MB-201 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 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, 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. 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

M.Sc. (Microbiology)

(SEMESTER-II)
MB-202 Microbial Physiology and Development

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.

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, Entner Doudroff 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

Assimilation of nitrogen; Molecular biology of biological nitrogen fixation; nitrate and ammonia nitrogen, synthesis of major amino acids, polyamines; Synthesis of polysaccharides, peptidoglycan; Dormancy and germination; Microbial Differentiation, ; sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Cell division cycle in *E.coli* and yeast, Developmental cycle in Myxomycetes.

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)
MB-203 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 e.g. citric acid and lactic acid; Amino acids: Glutamate; Vitamins; Industrial enzymes. Production of secondary metabolites: Antibiotics (penicillin, cephalosporins, streptomycin, etc), Pigments, enzyme inhibitors; 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)

M.Sc. (Microbiology)
(SEMESTER-II)
MB-204 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, nosocomial infections, opportunistic infections. Role of aggressins, depolymerizing enzymes, organotrophism. Transmission and spread of infection.

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, Streptococcus pyrogenes, E. coli, Salmonella typhii, Shigella dysenteriae, Vibrio cholerae, Campylobacter, Haemophilus influenzae, Neisseria gonorrhoeae, 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, Kala-azar, Giardiasis, *Entamoeba histolytica*, toxoplasmosis & leishmaniasis; Superficial, subcutaneous, systemic and opportunistic mycoses, Ascariasis, Hookworm, Taenia, *Echinococcus granulosus*, Filariasis. Hospital acquired infections and their management

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)
MB-205 Microbial Energetics

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; energy and electron sources; Metabolite Transport: Diffusion: Passive and facilitated; Primary active and secondary active transport; Group translocation (phosphotransferase system) electro neutral transport; transport of Iron.

Unit II

Microbial Growth: Definition; salient features of growth curve; generation time; specific growth rate; batch and continuous culture; synchronous growth; diauxic growth curve. Measurement of cell numbers; cell mass and metabolic activity. Environment and microbial growth.

Unit III

Brief account of photosynthesis - oxygenic-anoxygenic photosynthesis; fixation of $C0_2$- Calvin cycle - C3-C4 pathway. Chemolithotrophy - sulphur - iron - hydrogen - nitrogen oxidations; methanogenesis; luminescence. Respiratory metabolism – Embden-Mayer Hoff pathway - Entner Doudroff pathway - glyoxalate pathway - Krebs cycle - oxidative and substrate level phosphorylation - reverse TCA cycle; homo and heterolactic fermentation.

Unit IV

Biosynthesis of peptidoglycan; Biosynthesis of biopolymers; Assimilation of nitrogen, sulpher, phosphorus etc.; Biosynthesis of amino acids, vitamins and nucleotides and their regulation.

Suggested readinigs

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)

P2–MB: Bacterial Diversity, Microbial Energetics, Microbial Physiology, Industrial and Medical Microbiology Lab

Time: 6 hrs **M. Marks: 150**

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.

Microbial Physiology and Energetics: Use of simple techniques in laboratory (Colorimetry, Centrifugation; Electrophoresis and GLC); Determination of viable and total number of cells, Measurement of cell size, Growth – types of growth (synchronous, diauxic, batch), study factors affecting growth, Sporulation and spore germination in bacteria; Induction and repression of enzymes; Study of bacterial growth under aerobic, micro, aerophilic and anaerobic conditions; Morphological, Physiological and Biochemical tests of selected bacterial cultures. Production of amino acids and vitamins by microorganisms.

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.

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-III)

MB-301 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)

MB-302 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; Cytological basis of 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

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, T_4 and lambda phage. Mapping bacterial genes by transduction; Positive and negative gene regulation and attenuation, using the *lac*, *gal*, *trp*, *ara* and *tol* 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 and f1. 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 system in *Salmonella*.

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-III)

MB-303 Environmental 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 to Microbial Ecology: Evolution of Life on Earth; History and scope of ecology, Concept of autecology, synecology, population, community, biome. Ecological succession. Microorganism in aquatic Environment: major physical and chemical factors (light, temperature, gases, nutrients). Aquatic biota: phytoplankton, zooplankton, benthos, periphyton, macrophytes. Biofilms, Production in lakes, rivers, estuaries and wetlands. Nutrient dynamics in lakes, rivers, estuaries and wetlands. Eutrophication and water pollution: monitoring and control conservation and management of lakes, rivers and wetlands.

Unit II

Microflora of air, assessment of air quality, droplet nuclei, aerosol, Classification of soils-physical and chemical characteristics, microflora of various soil types , bacteria and nematodes in relevance to soil types; rhizosphere, phyllosphere; Rehabilitation of unbalanced soils using microbes, Rehabilitation of specialized habitats: water bodies, mangroves, coral reefs; Microbial rehabilitation of mined area. Brief account of microbial interactions, biogeochemical cycles and the organisms, Biofertilizers, vesicular arbuscular mycorrhizae (VAM).

Unit III

Waste treatment: Wastes; types - solid and liquid wastes characterization, waste treatments: physical, chemical and biological. Aerobic, anaerobic, primary, secondary and tertiary treatments; solid waste treatment, saccharification, gasification, composting. Utilization of solid wastes; food (SCP, mushroom, yeast), fuel (ethanol, methane), fertilizer (composting), liquid waste treatment: trickling, activated sludge, oxidation pond and oxidation ditch.

Unit IV

Microbial diversity, use of micro-organisms like thermophiles, alkalophiles; acidophiles, halophiles and psychrophiles in waste treatment; production of enzymes like cellulase, laccase, proteases, amylases; alcohol and acetic acid production, Microbial leaching of low grade mineral ores, Petroleum pollutant biodegradation. Biodegradation of recalcitrant compounds: lignin, pesticides; Biodeterioration of paper, metal, stone, leather and wood.

Suggested Reading:

1. Johri B. N. 2000. Extremophiles. Springer Verlag. New York
2. Maier R. M. Pepper I. L. & Gerba C. P. 2000. Environmental Microbiology. Academic Press. USA.
3. Baker K. H. & Herson D. S. 1994. Bioremediation, MacGraw Hill Inc. N.Y.
4. Ralph M. A. 1997. Environmental Microbiology. John Wiley and Sons. Inc.
5. Forster C. F. & John D. A. 2000. Environmental Biotechnology, Ellis Horwood Ltd. Publication.
6. Christon J. H. 2001. A Manual of Environmental Microbiology, ASM Publications.
7. Sharma P. D. 2005. Ecology and Environment, Rastogi Publication.
8. Kuhad R. C. and Singh A. 2007. Lignocellulose Biotechnology: Future Prospects. I. K. International Publishing House Pvt. Ltd.

M.Sc. (Microbiology)

(SEMESTER-III)

MB-304 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. Generation of immune response: B-cell maturation in bone marrow, humoral immune response; T cell maturation in thymus, thymic selection, Generationof cell-mediated immune response; 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)

MB-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

Microscopic techniques: light microscopy, Confocal Microscope, resolving powers of different microscopes, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM. Differential centrifugation and purification by density gradient centrifugation.

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; Spectrophotometry: Principles and applications UV, Visible, Mass Spectrometry, MALDI-TOF, Atomic Absorption Spectrometer, X- Ray spectroscopy

Unit IV

Antisense and RNAi technology, Protein and DNA sequencing techniques, Maxam–Gilbert sequencing, Chain termination methods, Massively Parallel Signature Sequencing (MPSS), Pyrosequencing, Illumina (Solexa) sequencing, Solid sequencing, Genomic and cDNA library preparation, RFLP, RAPD and AFLP techniques. Concept of radioactivity and counting methods with principles of different types of counters, Concept of α, β and γ emitters, γ-ray spectrometers, 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.

Wilson K & Walker J. 2000. Principles and Techniques of Practical Biochemistry. 5th Ed. Cambridge Univ. Press. 30

M.Sc. (Microbiology)
(SEMESTER-III)
MB-306 Communication Skill Development

Time: 3hrs **Marks: 50**

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.

Lectures: preparation, objectives, concepts, contents, sequence, formal proof, interrelationships, logic, conclusions, time management using audiovisual aids Giving a talk : body language : extempore and prepared talks.
Preparation for interviews and preparation of CV/ biodata.
Vocabulary: word power, pronunciations, guessing the meaning of words from the context an body language and using a dictionary Review of basic grammar Punctuation marks comma, colon, semicolon, full stop, inverted comma. Avoiding repetitious statements, double positive, double negatives, circular arguments. Dealing with questions: avoiding circumvention and circular arguments, answering after breaking down long question into parts.
MS power point -based presentations, Analysis of formal presentations in the course 3a in terms of actual presentations.

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

P3–MB: Molecular Microbiology, Microbial Genetics, Immunology, Biochemical & Biophysical Techniques and Environmental Microbiology

Time: 6 hrs **M. Marks: 150**

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.

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

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.

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.

Environmental Microbiology: Isolation and Staining of microorganisms: Simple staining and gram staining techniques, Screening of industrially important microorganisms from soils and industrial effluents, To evaluate the production of alcohol from molasses & ligno-cellulosics biomass, Microbial biomass production (fungi/bacteria/yeast) in batch and fed bacth cultures, To compare production of citric acid using sucrose and molasses as carbon source, Isolation of thermophilic microbes from environmental samples and screen them for hydrolytic enzymes, To study DNA isolation from environmental samples and study the microbial diversity, To study dye and industrial effluent treatment by the microbial cultures.

M.Sc. (Microbiology)

(SEMESTER-IV)

MB-401 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-IV)

MB-402 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- Classification and nomenclature, Bacteriophage structural organization; life cycle: lytic and lysogenic cycle, application of bacteriophages; brief details on M13,Mu,T3,T4, and Lamda P1. Viruses of cyanabacteria, algae, fungi.

Unit III

Plant Viruses- Classification and nomenclature;Structureand life cycle of plant viruses. Propagation,purification,characterization,identification and genomics of plant viruses like TMV, Cauliflower MosaicVirus ,Gemini virus and Potato Virus X Symptoms of plant virus diseases, Transmission of plant viruses,Viral diseases and their control.Some common viral diseases of plants. Viral and Viriod diseases:Papaya ring spot, rice tungro, tomato yellow leaf curl, Potato spindle tuber, coconut cadang cadang.

Unit IV

AnimalViruses-Classification and nomenclature;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, Toga, Rhabdo,Rota, Pox, Herpes, Adeno, Hepatitis, HIV and other Oncogenic viruses; viral vaccines (conventional vaccines,genetic recombinant vaccines used in national immunisation programmes with examples, newergeneration 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-Ill 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, Virology and Immunology. Edward Arnold, London.

M.Sc. (Microbiology)
(SEMESTER-IV)
MB-500 Dissertation in Microbiology

M.M. 300

Note: The Dissertation will be based upon research and actual bench work. It will be carried out in IVth Semester, but will be started in the IIIrd Semester. The dissertation will be submitted at the end of semester and will be evaluated by external and internal examiners.

M. Sc. Dissertation Rules (w.e.f. 2013-14)

Distribution/Allotment of student: to be done at Department level but ratio of distribution to be done as per Ph. D. Seats *i.e.* in 8:5:3 ratio. The dissertation is to be innovative work based on small piece of research with duration in 3rd and 4th semesters. Scheme of chapters of dissertation is as follows-

Acknowledgement

Certificate by Supervisor

(i) Introduction with objectives
(ii) Review of Literature (Brief)
(iii) Materials & methods
(iv) Results
(v) Discussion
(vi) Summary
(vii) Bibliography

Pattern of References/Typing/Figures as per Ph. D. Thesis. Last date of submission will usually be 30th June. The evaluation of dissertation will be done by external examiner (Approved by the VC from panel approved by PGBOS) and internal examiner (Guide). Final marks will be mean of Internal + External.

The written part of Dissertation report shall account for 250 of marks and the viva-voice will be conducted by a duly constituted Board of Examiners for the remaining 50 of marks. Dissertation report will be evaluated on the basis of below given criteria:

Performance Evaluation Parameter	Score
Writing quality	50
Novelty/Scientific significance of aim	50
Project design	50
Publication potential	50
Aim-Results concurrence	50

No. of copies of Dissertation will be-One copy for Deptt. record, One copy for Guide record. One copy for candidate and soft copy to library. Any pattern/IPR based on Dissertation will be in the name of MDU student & Guide as inventor. Publication based on Dissertation will be under control of guide.