

**Examination scheme of M.Sc. Microbiology (semester system) w.e.f. the  
academic session 2009-2010**

Paper no	Nomenclature of Paper	Marks of internal assessment	Marks of Th. Paper/ practical	Total Marks	Duration of theory exam/ Practical exam
<b>First Semester</b>					
MB101	Bacteriology	20	80	100	3 hours
MB102	Virology	20	80	100	3 hours
MB103	Mycology, phycology, Microalgae, fungi	20	80	100	3 hours
MB104	Biochemistry	20	80	100	3 hours
MBP101	General microbiology			50	6 hours
MBP102	Analytical biochemistry			50	6 hours
			Total	500	
<b>Second semester</b>					
MB201	Molecular biology	20	80	100	3 hours
MB202	Microbial genetics	20	80	100	3 hours
MB203	Fundamentals of infection & immunity	20	80	100	3 hours
MB204	Microbial physiology and development	20	80	100	3 hours
MBP201	Microbial genetics and molecular biology			50	6 hours
MBP 202	Microbial physiology and Immunology			50	6 hours
			Total	500	
<b>Third semester</b>					
MB301	Cellular microbiology	20	80	100	3 hours
MB302	Recombinant DNA technology	20	80	100	3 hours
MB303	Medical Microbiology	20	80	100	3 hours
MB304	Microbial Technology	20	80	100	3 hours
MBP301	Recombinant DNA technology			50	6 hours
MBP302	Diagnostic Microbial and Immunology			50	6 hours
			Total	500	
<b>Fourth semester</b>					
MB401	Fundamentals of Immunology	20	80	100	3 hours
MB402	Environmental Microbiology	20	80	100	3 hours
MB403	Food Microbiology	20	80	100	3 hours
MB404	Fermentation Technology	20	80	100	3 hours
MBP401	Immunology and Environmental Microbiology			50	6 hours
MBP402	Food and Fermentation Technology			50	6 hours
			Total	500	
		Grand Total		2000	

**Chairman, P.G Board of Studies**

## **M.Sc. MICROBIOLOGY SYLLABUS**

### **FIRST SEMESTER**

- 101. Bacteriology
- 102. Virology
- 103. Mycology Phycology, Microalgae & Fungi
- 104. Biochemistry
- P101. General Microbiology
- P102. Analytical biochemistry

### **SECOND SEMESTER**

- 201. Molecular biology
- 202. Microbial Genetics
- 203. Fundamentals of infection and immunity
- 204. Microbial Physiology and Development
- P201. Microbial genetics and Molecular biology
- P202. Microbial Physiology and Immunology

### **THIRD SEMESTER**

- 301. Cellular Microbiology
- 302. Recombinant DNA technology
- 303. Medical Microbiology
- 304. Microbial Technology
- P301. Recombinant DNA Technology
- P302. Diagnostic Microbiology and Immunology

### **FOURTH SEMESTER**

- 401. Fundamentals of Immunology
- 402. Environmental Microbiology
- 403. Food Microbiology
- 404. Fermentation Technology
- P 401. Immunology & Environmental Microbiology
- P 402. Food and Fermentation Technology

## **M.Sc. MICROBIOLOGY SYLLABUS**

### **101. Bacteriology**

#### **Unit 1**

Morphology and ultra structure of bacteria - morphological types - cell walls of archaeobacteria gram negative - gram positive eubacteria - eukaryotes, L-forms - cell wall synthesis, antigenic properties - capsule - types, composition and function, cell membranes - structure – composition properties.

#### **Unit 2**

Structure function of flagella - cilia - pili - gas vesicles - chromosomes, carboxysomes -magnetosomes and phycobolosomes - nucleoid - cell division - spores.

#### **Unit 3**

Reserve food materials - polyhydroxybutyrate - polyphosphate granules - oil droplets -cyanophycin granules and sulphur inclusions.

#### **Unit 4**

Cultivation of bacteria - aerobic - anaerobic - shaker - still - nutritive types - culture media used - growth curve - generation time - growth kinetics - asynchronous - synchronous – batch- continuous culture - measurement of growth and factors affecting growth, control of bacteria - physical and chemical agents - preservation methods.

#### **Unit 5**

Classification of micro organisms - introduction - Haeckel's three kingdom concept - Whittaker's five kingdom concept - three domain concept of Carl Woese, Basis of microbial classification, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology, cyanobacteria, prochlorons and cyanelles.

#### **Text Books**

1. A.J. Salle, Fundamental Principles of Bacteriology.
2. Brock T.D, Madigan M.T, Biology of Microorganisms. Prentice Hall Int. Inc.
3. Pelczar M.J., Chan E.C.S, Kreig N.R. Microbiology, Mc Graw Hill.

#### **References**

1. Bergey's Manual of Systematic Bacteriology - P.H.A. Sneath, N.S. Mair, M.Elizabeth.
2. The Prokaryotes, A. Balows, A.G. Thuper, M. Dworkin, W.Harder, K.Schleifer Springer - Verlag 1991.
3. Sharpe, J.G. Holt, - Williams and Wilkins - 4 volumes.
4. The prokaryotes, A. Balows, A.G. Thuper, M. Dworkin, W.Harder, K.Schleifer - Springer - Verlag 1991.

5. Zubey GL, Parson WW and Vance DE (1994) Principles of Biochemistry - WM.C.Brown, Publishers, Oxford, England.
6. Stryer L (2001) Biochemistry W.H. Freeman Company, New York.
7. Brige EA (1992) Modern Microbiology - WM.C.Brown, Publishers., Oxford, England.
8. A.J. Salle, Fundamental Principles of Bacteriology.
9. Stainer RY, Ingharam JL, Wheelis ML, Painter PR (1999) General Microbiology, Macmillan Educational Ltd., London.
10. Gebhardt LP Microbiology C.V. Mosby Company.
11. Gunsales IC, Stainer RY The bacteria Vol. I, II, III, Academic Press.
12. Brock TD, Madigan MT, Biology of microorganisms. Prentice Hall Int. Inc.
13. Joklik WK, Zinssers Microbiology, Mc Graw - hill Companies.
14. Pelczar MJ, Chan ECS, Kreig NR. Microbiology, Mc Graw Hill

## M.Sc. MICROBIOLOGY SYLLABUS

### 102. Virology

#### **Unit 1: General Virology**

Brief outline on discovery of viruses, nomenclature and classification of viruses; distinctive properties of viruses; morphology & ultrastructure; capsids & their arrangements; types of envelopes and their composition-viral genome, their types and structures; virus related agents(viroids, prions).

#### **Unit. 2: General Methods of Diagnosis and Serology.**

Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems; serological methods - haemagglutination & HAI; complement fixation; immunofluorescence methods, ELISA and Radioimmunoassays; 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.

#### **Unit 3: Bacterial Viruses**

Bacteriophage structural organization; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; phage production; burst size; lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13,Mu,T3,T4, and Lamda P1.

#### **Unit 4: Plant Viruses**

Classification and nomenclature; effects of viruses on plants; appearance of plants; histology, physiology and cytology of plants; common virus diseases of plants; paddy, cotton, tomato, and sugarcane; viruses of cyanobacteria, algae, fungi; life cycle; type species of plant viruses like TMV, Cauliflower Mosaic Virus and Potato Virus X; transmission of plant viruses with vectors (insects, nematodes, fungi) and without vectors (contact, seed and pollens); diagnostic techniques in seeds; seed stocks and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histochemical tests and fluorescent microscopy); prevention of crop loss due to virus infection-virus-free planting material; vector control.

#### **Unit 5: Animal Viruses**

Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA Viruses Picorna.Ortho myxo, Paramyxo, Toga and other arthropod viruses, Rhabdo.Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses, viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunisation programmes with examples, newer generation vaccines including DNA Vaccines with examples) interferons, and antiviral drugs.

**Text Books**

1. Morag C and Timbury M.C (1994) Medical virology-X Edition. Churchill Livingstone, London.
2. Dimmock NJ, Primrose SB (1994). Introduction to Modern Virology, IV Edition, Blackwell Scientific Publications, Oxford
3. Conrat HF, Kimball PC and Levy JA (1994) Virology-III Edition Prentice Hall, Englewood cliff, New Jersey.
4. Mathews, RE.,(1992) Functionals of Plant virology, Academic press, San Diego.
5. Topley and Wilson's (1995) Text Book on Principles of Bacteriology, Virology and Immunology. Edward Arnold, London.
6. Lenetter, EH (1984) Diagnostic procedures for Viral and Rickettsial diseases. American Public Health association, NY.
7. William Hayes (1985) The genetics of Bacteria and their Viruses. Blackwell Scientifi Publishers, London.

## M.Sc. MICROBIOLOGY SYLLABUS

### 103. Mycology and Phycology

#### Unit 1

Historical introduction to mycology structure and cell differentiation. Division myxomycota Acrasiomycetes, hydromyxomycetes, myxomycetes, Plasmodiophoromycetes. Zoosporic fungi— Chytridiomycetes, Hypochytridiomycetes, oomycetes. Zygomycotina - Zygomycetes, Trichomycetes - Evolutionary tendencies in lower fungi.

#### Unit 2

Ascomycotina - Hemiascomycetes, plectomycete, pyrenomycetes Discomycetes, laboulberiomycetes, oculoascomycetes. Basidiomycotina teliomycetes, hymenomycetes. Deuteromycotina - hypomycetes, coelomycetes, blastomycetes.

#### Unit 3

Heterothalism.sex hormones in fungi.Physiological specialization phylogeny of fungi, Lichens -ascolichens, basidiolichens, deuterolichens. Mycorrhiza - ectomycorrhiza, endomycorrhiza, vesicular arbuscular mycorrhiza.fungi as insect symbiont, Fungal diseases - mycoses systemic and subcutaneous, candidiasis, Pneumocystis, blastomycoses, dermatophytosis.

#### Unit 4

Fungi and ecosystem

#### Unit 5

Distribution of algae,classification of algae, algal nutrition, algal thallus, algal reproduction, greenalgae, diatoms, euglenoids, brown Rhodophyta, pyrrophyta. Algal ecology and algal biotechnology

#### Text Books

1. Mehrotra, R.S. and K.R. Aneja 1990. An Introduction to Mycology. New Age International publishers.
2. Alexopoulos, C.J. and C.W. Mims 1979. Introduction to Mycology (3<sup>rd</sup> Ed.) Wiley Eastern Ltd., New Del
3. The Fungi. M.Charlile & S.C. Watkinson, Publisher: Academic Press.
4. Fundamentals of the fungi. E.Moore - Landeeker, Publisher: Prentice Hall.
5. Fundamentals of Mycology, J.H. Burnett, Publisher: Edward, Arnold Crane Russak.

## M.Sc. MICROBIOLOGY SYLLABUS

### 104. Biochemistry

#### Unit 1

Composition of living matter, biochemistry of bacterial, animal and plant cell, specialized components of microorganisms and their structure and function.

#### Unit 2

Enzymes as biocatalysts, enzyme classification, specificity, active site, activity unit, isozymes. Enzyme kinetics: Michaelis - Menton equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps, enzyme inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

#### Unit 3

Structural features and chemistry of macromolecules; nucleic acid, proteins, carbohydrates and lipids and biomolecules such as antibiotics, pigments and other secondary metabolites.

#### Unit 4

Bioenergetics and strategy of metabolism: flow of energy through biosphere, strategy of energy production in the cell, oxidation - reduction reactions, coupled reactions and group transfer, ATP production, structural features of biomembranes, transport, free energy and spontaneity of reaction,  $G$ ,  $G^\circ$ ,  $G$  and equilibrium, basic concepts of acids, base, pH and buffers.

#### Unit 5

Cell metabolism: catabolic principles and break down of carbohydrates, lipids, proteins and nucleic acids, biosynthesis of macromolecules, hormone regulation of metabolism, vitamins and their role as coenzymes.

#### Text books

1. Biochemistry, Stryer 5<sup>th</sup> edition W.H. Freeman 2001.
2. Principles of Biochemistry, Lehninger, 3<sup>rd</sup> edition by Nelson and Cox (Worth) 2000. Publisher.

## M.Sc. MICROBIOLOGY SYLLABUS

### P 101. General Microbiology

Microscopy - Microscope and its operations - components - Microscope adjustments - Light sources - microscopic measurements - calibration; Types of microscope available - theory. Observation of various types of microbes under phase contrast, dark field and fluorescence.

Preparation of glassware - washing - sterilization techniques - wet heat - dry heat - filter types - laminar flow chamber types - CDC - safety levels.

Preparation of culture media - nutritional needs of microbes - dehydrated - selective -differential - autotrophic - heterotrophic. Culture techniques - adjustment of pH - buffers - pure culture techniques - preparation of slants, subculturing.

Microbial growth measurements - cell count - turbidity measurement - percentage transmission, Optical Density - serial dilution - standard plate count.

Morphological, nutritional and cultural characteristics of bacteria and identification of microbes; types of dyes - preparation - staining techniques - simple - Gram s- capsule -negative - flagella. spore and nuclear.

### References

1. Experimental Microbiology Laboratory guide, Robert C. Coss, Kalyani Publishers, Ludhiana.
2. Microbiology - A Laboratory manual - J.G. Cappucino, N. Sherman, Benjamin/ Cummings - 1996.
3. Handbook of Microbiological Media - Himedia.

## M.Sc. MICROBIOLOGY SYLLABUS

### P 102. Analytical Biochemistry

**Measurement:** criteria of reliability, precision, accuracy, sensitivity, specificity.  
Laboratory rules and safety regulations, first aid.

Principles of colorimetry: verification of Beer's law, estimation of a selected protein, finding out  $I_{max}$ , relation between O.D. and percentage transmission, isolation and quantification of DNA from microorganism or other sources.

pH, pK, Henderson-Hasselbach equation, preparation of buffers.

Separation of amino acids by paper chromatography.

Isolation of phospholipids from liver and their separation by thin layer chromatography.

Separation of haemoglobin and blue dextran by gel filtration.

Ion exchange chromatography: CM cellulose and DEAE cellulose

Cell fractionation into nuclear, mitochondrial and cytoplasmic fractions; estimation of marker enzymes

## M.Sc. MICROBIOLOGY SYLLABUS

### 201. Molecular Biology

#### Unit 1

Nucleic acids as genetic information carriers: experimental evidence. DNA structure: historical aspects and current concepts, melting of DNA. DNA replication: general principles, various modes of replication, isolation and properties of DNA polymerases, proof reading, continuous and discontinuous synthesis. Asymmetric & dimeric nature of DNA polymerase III and simultaneous synthesis of leading and lagging strands, DNA polymerase, exonuclease activity in eukaryotic DNA polymerases. Superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases.

#### Unit 2

Initiation of replication of single stranded DNA. Construction of replication fork in test tube. Retroviruses and their unique mode of DNA synthesis. Relationship between replication and cell cycle. Inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization, altering DNA structure). DNA damage and repair: types of DNA damage (deamination, oxidative damage, alkylation, pyrimidine dimers). Repair pathways - methyl-directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination, repair, SOS system.

#### Unit 3

Structural features of RNA (rRNA, tRNA and mRNA) and relation to function. Initiator and elongator class of tRNA, ribosome binding site on mRNA and corresponding site on rRNA, peptidyl transferase activity of 23S rRNA. Transcription: general principles, basic apparatus, types of RNA polymerases, steps: initiation, elongation and termination, inhibitors of RNA synthesis. Polycistronic and monocistronic RNAs. Control of transcription by interaction between RNA polymerases and promoter regions, use of alternate sigma factors, controlled termination: attenuation and antitermination.

#### Unit 4

**Regulation of gene expression:** operon concept, catabolite repression, instability of bacterial RNA, positive and negative regulation, inducers and corepressors. Negative regulation - E. coli lac operon; positive regulation - E. coli ara operon; regulation by attenuation - his and frp operons; antitermination - N protein and nut sites in I. DNA binding proteins, enhancer sequences and control of transcription. Identification of protein- binding sites on DNA. Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA synthesis.

**Maturation and processing of RNA:** methylation, cutting and trimming of rRNA; capping, polyadenylation and splicing of mRNA; cutting and modification of tRNA degradation system. Catalytic RNA, group I and group II intron splicing, RNase R

### **Unit 5**

Basic features of the genetic code. Protein synthesis: steps, details of initiation, elongation and termination, role of various factors in the above steps, inhibitors of protein synthesis. Synthesis of exported proteins on membrane-bound ribosomes, signal hypothesis. In vitro transcription and translation systems

### **References**

1. Genes VII. Lewin (Oxford University Press) 2000.
2. E.coli and Salmonella, Cellular and molecular biology, 2<sup>nd</sup> edition.
3. Neidhardt et. al 1996. (ASM press).
4. Molecular cell biology (W.H.Freeman) by Lodish, Berk, Zippursky.
5. Matsudaira, Baltimore, Darnell, 4<sup>th</sup> edition, 2000.

## M.Sc. MICROBIOLOGY SYLLABUS

### 202. Microbial Genetics

#### Unit 1

Gene as unit of mutation and recombination. Molecular nature of mutations; mutagens. Spontaneous mutations - origin.

#### Unit 2

Gene transfer mechanisms - transformation, transduction, conjugation and transfection. Mechanisms and applications. Genetic analysis of microbes. Bacteria and yeast.

#### Unit 3

Plasmids, F- factors description and their uses in genetic analysis. Colicins and col factors. Plasmids as vectors for gene cloning. Replication of selected plasmids: compatibility. Transposons and their uses in genetic analysis.

#### Unit 4

Bacteriophages, Lyticphages-T7andT4. Lysogenic phages I and P1. M13andfX174. Life cycle, and their uses in microbial genetics.

#### Unit 5

Microbial genetics and design of vaccines. BCG and design of vaccine for TB and leprosy. DNA vaccines, design and advantages.

#### Text Books

1. Microbial Genetics. Maloy et. al. 1994. Jones & Bartlett Publishers.
2. Molecular genetics of bacteria. J.W. Dale 1994. John Wiley & Sons.
3. Modern microbial genetics. 1991. Streips & Yasbin. Niley. Ltd.

## M.Sc. MICROBIOLOGY SYLLABUS

### 203. Fundamentals of Infection and Immunity

#### Unit 1

**Principles of Medical Microbiology:** Classification of medically important microorganisms. Normal microbial flora of human body; Origin of normal flora; normal flora and human host.

#### Unit 2

**Infection:** Sources of infection for man; vehicles or reservoirs of infection. Exogenous Infection: 1) Patients; 2) carriers - (Healthy; convalescent; contact; paradoxical and chronic); 3) Infected animals (zoonosis); 4) Soil endogenous infection. Mode of spread of infection: 1. Respiratory; 2) skin; 3) wound and burn infection; 4) Venereal infections; 5) Alimentary tract infection; 6).Arthropod - borne blood infections & 7) Laboratory infections. Pathogenesis: Microbial Pathogenicity: Transmissibility, Infectivity and Virulence. Opportunistic pathogens; True pathogens. Toxicogenicity; Invasiveness, Other aggressins (Hyaluronidase), coagulase, Fibrinolysins or kinase; depolymerizing enzymes (mucinase, lipases, proteases, nucleases, collagenase, neuraminidase. Organofropism, variation and virulence.

#### Unit 3

**Immune system:** Organs and cells involved in immune system and Immune response Lymphocytes, their subpopulation, their properties and functions, Membrane bound receptors of lymphcells, HelperT cells in Immune response, Tcell suppression in Immune response; Antigens: types of antigens - antigens specificity - haptens. Natural or Innate Immunity: Determinants of innate immunity; species and strains; individual differences; influence of age, hormonal influence, nutritional factors, mechanical barriers and surface secretions. Non specific Immune mechanisms; surface defences, Tissue defences; Opsonization; Inflammatory reactions; hormone balance; Tissue metabolites with bacterial properties (Lysozymes, Nucleins, Histones, Protamines, Basic peptides of tissues - Leukins, phagocytins; Lecterin; Heme compounds) Interferon, properdin and complement.

#### Unit 4

**The Immune Response:** Humoral, cellular, actively acquired, passively acquired Cellular Interaction in the induction of antibody formation - cellular interactions in the induction of immune T cells - Lymphoid cell interactions, in vivo - immune memory - control of antibody production  
- Theories of antigen recognition; types of immunity; immune tolerance and auto immunity; cytokines; form, dose and route of entry of antigen. Defects in Immunoglobulin synthesis and cell mediated immunity: Primary defects; Secondary defects, Defective phagocyte mechanisms; Immunosuppression - specific; nonspecific.

## Unit 5

Immunity to infection: Immunity to Microbial infections, Prophylaxis, Vaccines.

### Text Books

1. Barrett, J.T. "Textbook of Immunology (1983); An Introduction to Immunochemistry and Immunology". Mosby, Missouri.
2. Boyd, R.F., "General Microbiology", (1984): Times Mirror/Mosby (college publishing, St.Louis).
3. Broude A.I. (1981): Medical "Microbiology": and Infectious Diseases W.B. Saunders & Co., Philadelphia
4. Chapel and Haeney, "Essentials of Clinical Immunology: (1984): Blackwell Scientific Publications.

### References

1. Clark, W.R., "The Experimental Foundations of Modern Immunology (1991): John Wiley and Sons. Inc.
2. Mackie & McCartney - Medical Microbiology - 14<sup>th</sup> Ed.
3. Vol. 1: Microbial infections.
4. Vol. 2: Practical Medical Microbiology. 1996 Churchill Livingstone London.
5. Bailey & Scott's Diagnostic Microbiology
6. Ellen JO Baron, Lance R. Peterson, Sydney M.Finegold 9<sup>th</sup> Ed. 1994, Moseby.
7. Franklin, T.J., Snow G.A. Biochemistry of Antimicrobial Action:, (1981): Chapman and Hall., New York.
8. Roitt, I.M: Essential Immunology (1995): Blackwell Scientific Publications, Oxford.
9. Roth, J.A. (1985): Virulence Mechanism of Bacterial Pathogens. American Society for Microbiology, Washington D.C.
10. Smith, C.G.C. "Epidemiology and Infections" (1976): Medowfief Press Ltd., Shildon, England.
11. Stiehm F. (1980), "Immunological Disorders in Infants and Children" (1980): W.B. Saunders & Co., Philadelphia.
12. Stites, D.P. Stobo, J.D. feudenberg, H.H., Wells J.V.:Basic and Clinical Immunoloty, (1984): Lange Medical Publications., Los Altos., Clifomia.
13. Todd, I.R. (1990): Lecture Notes in Immunology, Blackwell Scientific Publications Ltd., Oxford.
14. Roit IM, Brostoff and Male 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> ed. 1989, 1994, 1995 Immunology - Gower Medical Publishing Co.,
15. Fundamental immunology - W.E. Paul 1984, Raven Press, Yew York.
16. Fundamentals of Immunology - R.M. Coleman, M.F. Lombord and R.E. Sicard (1992) - 2<sup>nd</sup> ed. C. Brown publishers.
17. Immunology - D.M. Weir and J Steward 7<sup>th</sup> Ed. (1993).

## M.Sc. MICROBIOLOGY SYLLABUS

### 204. Microbial Physiology and Development

#### Unit 1

Basic aspects of bioenergetics - entropy - enthalpy - electron carries - artificial electron donors - inhibitors - uncouplers - energy bond - phosphorylation.

#### Unit 2

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<sub>2</sub>- Calvin cycle - C3-C4 pathway. Chemolithotrophy - sulphur - iron - hydrogen - nitrogen oxidations, methanogenesis-luminescence.

#### Unit 3

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 4

Assimilation of nitrogen - dinitrogen - nitrate nitrogen - ammonia - synthesis of major amino acids- polyamines; Synthesis of polysaccharides - peptidoglycan - biopolymers as cell components; - cell division - endospore - structure - properties - germination.

#### Unit 5

Microbial development, sporulation and morphogenesis,hyphae vs yeast forms and their significance. Multicellular organization of selected microbes. Dormancy

#### Text Books

1. Caldwell, D.R. 1995. Microbial Physiology and metabolism. Brown publishers.
2. Moat.A.G. & Foster J.W. 1999. Microbial Physiology. Wiley.
3. Stainer RY, Ingharam JL, Wheelis, ML, Painter PR (1986) General Microbiology, Macmillan Education Ltd., London.
4. Brun, Y.V. and Shimkets, L.J. 2000. Prokaryotic Development. ASM press.

## M.Sc. MICROBIOLOGY SYLLABUS

### P 201. Microbial Genetics and Molecular Biology

Single colony isolation and checking genetic markers.

One step growth curve of bacteriophage T4. Spontaneous and induced mutations - isolation of antibiotic resistant and auxotrophic mutants.

Selective enrichment of auxotrophic and antibiotic ( $tel^r$ ) mutants.

Genetic mapping by conjugation and P1 transduction.

Transposon mutagenesis.

Gene fusion using bacteriophage Mu.

Isolation of chromosomal DNA from E.coli. Estimation of DNA by spectrophotometry, plasmid DNA isolation and restriction digestion. Agarose gel electrophoresis.

### References

1. Short course in bacterial genetics. J.H. Miller 1992. CSH Laboratories.
2. Methods for General and molecular bacteriology. 1994. Murray et.al. ASM Press.
3. Experiments with Gene Fusions. 1994. T.Silhavy. Cold Spring Harbour Lab. Press.

## M.Sc. MICROBIOLOGY SYLLABUS

### 202. Microbial Physiology and Immunology

Measurement of ATP in a given bacterial suspension by bioluminescence method and correlation of the same by Viable count method.

Demonstration of bacterial growth under aerobic, micro-aerophilic and anaerobic conditions.

Demonstration of utilization of sugars by Oxidation and fermentation techniques.

Nutrition requirements of bacteria by employing appropriate culture techniques.

Demonstration on the influence of oxygen, carbon dioxide, temperature, on the growth of bacteria.

Factors affecting enzyme activity: temperature, substrate, concentration and pH using any stable enzyme and Kinetics of enzyme activity.

Study of isoenzymes of lactate dehydrogenase by PAGE

Various Agglutination reactions: Widal, Haemagglutination etc.

Various precipitation techniques: Immunodiffusion, Immuno electrophoretic method.

Enzyme Linked Immunosorbant Assay

Handling laboratory animals and raising antibodies

Raising antisera in animals

Separation and characterization of serum and lymphocytes from blood.

### References

1. Alcamo, I.E. 2001. Laboratory fundamentals of Microbiology. Jones and Bartlett!
2. Hudson, L, and Hay, F.C. 1989. Tical Immunology. Blackwell Scientific Publications.

## M.Sc. MICROBIOLOGY SYLLABUS

### 301. Cellular Microbiology

#### Unit 1

**Introduction:** bacterial diseases. Emergence of cellular microbiology. Cellular biology underlying prokaryotic and eukaryotic interactions: ultrastructure, genome expression, pathogenicity islands.

#### Unit 2

**Prokaryotic & eukaryotic signalling mechanisms:** eukaryotic cell-to-cell signalling endocrine signalling, cytokines Prokaryotic signalling: quorum sensing and bacterial pheromones Intracellular signalling. Signalling pathways.

#### Unit 3

Infection and cell - cell interactions; bacterial adherence: basic principles, effect of adhesion on bacteria, effect of adhesion on host cells. Bacterial invasion of host cells: mechanism, consequence of invasion survival after invasion. Protein toxins: agents of diseases.

#### Unit 4

Immune response to bacterial infection. Innate response: complement , acute phase proteins, macrophages: cytokines & Interferons. Acquired immune response cell mediated immune response, humoral response.

#### Unit 5

**Cellular microbiology future directions:** comparative genomics and functional genomics. Genome evolution in microbes. Phylogenetic trees.

#### References

1. Cellular Microbiology. 1999. Henderson et. al. Wiley
2. Bacterial genomes 1998. deBruijn et. al. Chapman & Hall.
3. Dorman C.J. 1994. Genetics of bacterial Virulence. Blackwell.

## **M.Sc. MICROBIOLOGY SYLLABUS**

### **302. Recombinant DNA Technology**

#### **Unit 1**

Core techniques and essential enzymes used in rDNA technology. Restriction digestion, ligation and transformation.

#### **Unit 2**

Cloning vectors - plasmids, phages and cosmids. Cloning strategies. Cloning and selection of individual genes, gene libraries: cDNA and genomic libraries.

#### **Unit 3**

Specialised cloning strategies. Expression vectors, Promoter probe vectors, vectors for library construction - artificial chromosomes.

#### **Unit 4**

PCR methods and application.

#### **Unit 5**

DNA sequencing Methods; dideoxy and chemical method. Sequence assembly. Automated sequencing. Genome sequencing and physical mapping of genomes.

#### **References**

1. Principles of gene manipulation. 1994. Old & Primrose. Blackwell Scientific Publications.
2. Molecular cloning. 3 volumes. Sambrose and Russell. 2000. CSH press.
3. Genome analysis. Four volumes. 2000. CSH Press.

## M.Sc. MICROBIOLOGY SYLLABUS

### 303. Medical Microbiology

#### Unit 1

Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important micro organisms; Normal microbial flora of human body; role of the resident flora; normal flora and the human host.

#### Unit 2

Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response.

#### Unit 3

Classification of pathogenic bacteria. Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Cornebacterium Bacillus, Clostridium, Non sporing Anaerobes, Organisms belonging to Enterobacteriaceae, Vibrios, Non fermenting gram negative bacilli Yersinia; Haemophilus; Bordetella, Brucella; Mycobacteria, Spirochaetes, Anctiomycetes; Rickettsiae, Chlamdiae.

#### Unit 4

General properties of Viruses; Viruses Host interactions; Pox viruses; Herpes virus, Adeno viruses; Picarno Viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses (AIDS). Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis.

#### Unit 5

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules; passive prophylactic measures; Noscomical infection, common types of hospital infections and their diagnosis and control.

#### References

1. Text of Microbiology, R. Ananthanarayanan and C.K. Jayaram Panicker Orient Longman, 1997.
2. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection. Vol.2: Practical Medical Microbiology Churchill Livingstone, 1996.
3. Microbiology in Clinical Practice. D.C. Shanson, Wright PSG, 1982.
4. Bailey and Scott's Diagnostic Microbiology Baron EJ, Peterson LR and Finegold SM Mosby, 1990.

## M.Sc. MICROBIOLOGY SYLLABUS

### 304. Microbial Technology

#### Unit 1

Biotechnological innovations in the chemical industry, biocatalyst in organic chemical synthesis, efficiency of growth and product formation, growth stoichiometry, maintenance energy requirement and maximum biomass, yield, P/O quotients, metabolite overproduction and growth efficiency.

#### Unit 2

Shake flask, stirred tank airlift fermenter, fed batch, continuous and immobilised cell reactor. Large scale production.

#### Unit 3

Metabolic pathways and metabolic control mechanism, industrial production of citric acid, enzymes, ethanol, acetic acid, production and diversification of antibodies. Steroids.

#### Unit 4

Biofertilizers, biopesticides, mushroom production, fermented food beverages. Biopolymers. Bioremediation.

#### Unit 5

Industrial strains. Strategies for selection and improvement, maintenance containment of recombinant organisms, large scale production using recombinant microorganisms. Product recovery.

#### Text Books

1. Biotechnological innovations in chemical synthesis. BIOTOL. Publisher: Butterworth-Heinemann.
2. Industrial Microbiology, G.Reed (editor), CBS Publishers (AVI Publishing Company)
3. Biology of industrial microorganisms. A.L Demain.
4. Genetics and biotechnology of industrial microorganisms. C.L.Hershnergev, S.W. Queener and Q.Hegeman. Publisher: American Society of Microbiology. Ewesis. et.al. 1998. Bioremediation principles. McGraw Hill.

## **M.Sc. MICROBIOLOGY SYLLABUS**

### **P 301. Recombinant DNA Technology**

tDNA cloning using plasmid vectors and in E.coli expression vectors.

Analysis of recombinant proteins using polyacrylamide gel electrophoresis.

Southern and Northern blotting

Restriction mapping - Plasmids.

PCR analysis

DNA sequencing. Sanger's method.

### **References**

1. Current protocols in molecular biology. 2000. Ausbel et. al.
2. Molecular cloning Vol.1-III. Sambrook & Russel. 2001. CSH press.

## M.Sc. MICROBIOLOGY SYLLABUS

### P 302. Diagnostic Microbiology and Immunology

Fixation of smears for microscopy by different methods  
Different staining techniques

- Simple (Loeffler's polychrome methylene blue and Negative staining
- Gram's staining
- Ziehl-Neelsen method for AFB
- Fluorochrome staining
- Leishman's stain
- Giemsa's staining
- Special staining methods to demonstrate granules, capsules and spores.

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

Diagnostic immunologic principles and methods

- |                        |                   |
|------------------------|-------------------|
| - precipitation method | - Immunodiffusion |
|                        | -                 |
|                        | Immunoelec        |
| trophoresis            |                   |
| Agglutination method   | - Widal test      |
|                        | -                 |
|                        | Haema             |
| gglutination           |                   |
| ELISA method           |                   |

Separation of serum protein by electrophoresis

Separation and characterization Of lymphocytes from blood.

Demonstration of lymphocyte sub population.

### References

1. Hudson and Hay Practical Immunology
2. Todd and Stanford Diagnostic methods in microbiology

## **M.Sc. MICROBIOLOGY SYLLABUS**

### **401. Fundamentals of Immunology**

#### **Unit 1: Immune System and Immunity**

History of Immunology; structures, composition and functions of cells and organs involved in immune system; host parasite relationships; microbial infections; virulence and host resistance; immune responses - innate Immunity, acquired Immunity; immunohaematology - bloodgroups, blood transfusion and Rh incompatibilities.

#### **Unit 2: Antigens and Antibodies**

Antigens - structure and properties - types - Iso and allo - haptens, adjuvants - antigen specificity. vaccines and toxoids. Immunoglobulins - structure - heterogeneity - types and subtypes -properties (physico Chemical and biological); Theories of antibody production. Complement -Structure -components - properties and functions of complement components; complement pathways and biological consequences of complement activation.

#### **Unit 3: Antigen-antibody Reactions**

Invitro Methods - agglutination, precipitation, complement fixation, immunofluorescence, ELISA, Radio Immunoassays; In vivo Methods: skin tests and immune complex tissue demonstrations. applications of these methods in diagnosis of microbial diseases.

#### **Unit 4: Major Histocompatibility Complex and Tumor Immunology**

Structure and functions of MHC and the HL-A system. Gene regulation and Ir-genes; HL-A and tissue transplantation - Tissue typing methods for organ and tissue transplantations in humans; graft versus host reaction and rejection; autoimmunity - theories, mechanism and diseases with their diagnosis; tumor immunology - tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors - detection of tumor markers - alphafoetal proteins, carcinoembryonic antigen etc.,

#### **Unit 5: Hypersensitivity Reactions**

Antibody - mediated - Type I. Anaphylaxis; Type II. Antibody dependent cell cytotoxicity; Type III. Immune complex mediated reactions; Type IV. Cell mediated hypersensitivity reactions. The respective diseases, immunological methods of their diagnosis. Lymphokines and cytokines - their assay methods.

#### **Text Books**

1. Roitt, I.M. (1998) Essentials of Immunology. ELBS, Blackwell Scientific Publishers, London.
2. Kuby, J (1994) Immunology II Edition. WH. Freeman and Company, New York.
3. Klaus D. Elgert (1996) Immunology-Understanding of Immune system. Wiley-Liss. NY.

## M.Sc. MICROBIOLOGY SYLLABUS

### 402. Environmental Microbiology

#### Unit 1

**Aerobiology:** Droplet nuclei, aerosol, assessment of air quality, - solid - liquid - impingement methods. - Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures.

#### Unit 2

**Aquatic microbiology:** Water ecosystems - types - fresh water (ponds, lakes, streams) - marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonations of water ecosystems - upwelling - eutrophication - food chain. Potability of water - microbial assessment of water quality - water purification - brief account of major water borne diseases and their control measures.

#### Unit 3

**Soil Microbiology:** Classification of soils - physical and chemical characteristics, microflora of various soil types (bacteria and nematodes in relevance to soil types; rhizosphere - phyllosphere  
 - brief account of microbial interactions symbiosis - mutualism - commensalism - competition  
 - amensalism - synergism - parasitism - predation; biogeochemical cycles and the organisms,  
 - carbon nitrogen - phosphorus and sulphur, biofertilizers - biological nitrogen fixation - nitrogenase enzyme - nif genes; symbiotic nitrogen fixation - (Rhizobium, Frankia) - non symbiotic microbes - Azotobacter - Azospirillum - (vesicular arbuscular mycorrhizae - VAM) ecto, endo, ectendomycorrhizae - rumen microbiology.

#### Unit 4

**Waste treatment:** Wastes - types - solid and liquid wastes characterization - solid - liquid; treatments - physical, chemical, biological - aerobic - anaerobic - primary - secondary - tertiary; 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 - oxidation ditch. Subterranean microbes and bioremediation

#### Unit 5

**Positive and negative roles of microbes in environment:** - biodegradation of recalcitrant compounds - lignin - pesticides; bioaccumulation of metals and detoxification - biopesticides; biodeterioration - of paper - leather, wood, textiles - metal corrosion - mode of deterioration - organisms involved - its disadvantages - mode of prevention. GMO and their impact.

1. Alexander, M. (1971) Microbial ecology. John Wiley & Sons, Inc., New York.
2. Alexander, M. (1977) Introduction to soil microbiology. John. Wiley & Sons. Inc., New York.
3. Ec Eldowney, S. Hardman, D.J. and Waite, S. 1993. Pollution: Ecology and biotreatment - Longman Scientific Technical.
4. Baker, KH, and Herson, D.S. 1994. Bioremediation. Mc Craw Hill Inc., New York.
5. W.C. Emeasst, (1982) The environment of the deep sea, Vol.II, J.g.Morin Rubey.
6. K.C. Marshall, (1985) Advances in microbial ecology Vol-8 Plenum Press.
7. Bums R.G., and Slater J.H. (1982) Experimental Microbial Ecology - Blackwell Scientific Publications, Oxford, London.
8. Norris, J.R. and Pettipher, G.L. (1987) Essays in agricultural and food microbiology, John Wiley and Sons Singapore.
9. Burges, A. and Raw, F. 1967. Soil Biology. Academic Press, London.
10. Martin Alexander Wiley. 1961. Introduction to soil Microbiology. Internationals; Edn, New York.
11. Vanghan, D. and Malcolm, R.E. 1985. Soil Organic matter and biological activity. Martinus Nighoff W. Junk Publishers.
12. Harry buckman and Nyle C.brady. 1960. The nature and properties of soil. Eurasis Pub. House (Pvt.) Ltd., New Delhi.
13. Brock TD, Madigan MT, Biology of microorganisms. Prentice Hall Int. Inc.

**Text Books**

1. Michel. R. Introduction to environmental microbiology. 1999
2. ASM book.

## M.Sc. MICROBIOLOGY SYLLABUS

### 403. Food Microbiology

#### Unit 1

**Food as substrate for microorganisms:** Micro organisms important in food microbiology -Molds, Yeasts and Bacteria-General characteristics-classification and importance. Principles of food preservation. Asepsis - Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying,). Factors influencing microbial growth in food - Extrinsic and intrinsic factors; Chemical preservatives and Food additives. Canning, processing for Heat treatment-D,Z, and F values and working out treatment parameters.

#### Unit 2

**Contamination and spoilage:** Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products- Fish and sea foods-poultry- spoilage of Canned foods. Detection of spoilage and characterisation.

#### Unit 3

**Food-borne infections and intoxications:** Bacterial and nonbacterial- with examples of infective and toxic types - Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia; Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks-laboratory testing procedures; Prevention Measures-Food sanitation in manufacture and retail trade; Food control agencies and its regulations, Plant sanitation-Employee's Health standards-waste treatment-disposal-quality control.

#### Unit 4

**Food fermentations:** bread, cheese, vinegar,fermented vegetables, fermented dairy products; Experimental and Industrial production methods. Spoilage and defects of fermented dairy products- oriental Fermented foods, their quality standards and control.

#### Unit 5

**Food produced by Microbes:** Fermented foods, microbial cells as food ( single cell proteins) - mushroom cultivation. Bioconversions- Production of alcohol-Fermented beverages-beer and wine. Steroid conversion - Industrial Enzymes production-amylases, proteinases, cellulases; Aminoacid production - glutamic acid and lysine productions. Genetically modified foods.

#### Text Books

1. Adams M.R. and Moss M.O (1995) Food Microbiology. Royal Society of Chemistry Publication, Cambridge.
2. Frazier WC and Westhoff Dc (1988). Food Microbiology. Tata McGraw Hill Publishing Company Ltd, New Delhi.
3. Stanbury, PR, Whitekar, A and Hall, S.J (1995) Principles of Fermentation Technology. 2<sup>nd</sup> Edition. Pergamon Press.

4. Banwart.GJ (1989) Basic Food Microbiology. CBS Publishers and Distributors, Delhi.
5. Hobbs BC and Roberts D.(1993) Food poisoning and Food Hygiene.Edward Arnold (A division of Hodder and Stoughton) London.
6. Robinson RK., (1990) Dairy Microbiology. Elsevier Applied Sciences, London.

## M.Sc. MICROBIOLOGY SYLLABUS

### 404. Fermentation Technology

#### Unit 1

General Considerations: Metabolic pathways and metabolic control mechanisms, primary and secondary metabolites.

#### Unit 2

Fermentation in batch culture: Microbial growth kinetics, measurement of growth (cell number, direct and indirect methods) growth and nutrient, growth and product formation, heat evolution, effect of environment (temperature, pH, high nutrient concentration) media formulation. Sterilization, kinetics of thermal death of micro-organisms, batch and continuous sterilization.

#### Unit 3

Continuous culture: Continuous culture system, productivity, product formation.

#### Unit 4

Aeration and agitation, power requirement oxygen transfer kinetics, concepts of Newtonian and Non-Newtonian fluids, plastic fluids apparent viscosity, foam and antifoam.

#### Unit 5

Scale-up, instrumentation control, physical and chemical environment sensors, downstream process.

#### Text Books

1. Stanbory P.F.A. Whitaker & Hall. 1995. Principles of Fermentation Technology. Pergaman. McNeul & H Fermentation.