

CIRCULAR:-

A reference is invited to the scheme of papers at the B.Sc. degree course under the revised pattern vide this office Circular No.UG/209 of 1999 dated 5<sup>th</sup> June, 1999 and the Principals of the affiliated colleges in Science are hereby informed that the recommendations made by the Board of Studies in Microbiology at its meeting held on 29<sup>th</sup> September, 2004 has been accepted by the Academic Council at its meeting held on 14<sup>th</sup> December, 2004 vide Item No.4.23 and that in accordance therewith the syllabus in the subject of Microbiology at the T.Y.B.Sc. course has been revised as per Appendix and that the same will be brought into force with effect from the academic year 2005-2006.

MUMBAI-400 032

27<sup>th</sup> April, 2005

To,

The Principals of the affiliated colleges in Science

for REGISTRAR

27/4/05

AC/4.23/14.12.04

No.UG/ 151-A of 2005, MUMBAI-400 032 27<sup>th</sup> April, 2005

Copy forwarded with compliments for information to :-

- 1) The Dean, Faculty of Science
- 2) The Chairman, Board of Studies in Microbiology

for REGISTRAR

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri for information.

The Officer on Special Duty-cum-Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), Record Section (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Affiliation Section (2 copies), the Director, Institute of Distance Education, (10 copies) the Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Deputy Registrar (Special Cell), the Deputy Registrar, (PRO) . the Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Executive Authorities Unit (2 copies) . They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that no separate Action Taken Report will be sent in this connection. the Assistant Registrar Constituent Colleges Unit (2 copies), PUCT (1 copy), the Deputy Account, Unit V (1 copy), the In-charge Director, Computer Facility (1 copy), the Receptionist (1 copy), the

# UNIVERSITY OF MUMBAI



## Revised Syllabus for T.Y.B.Sc. (Microbiology)

(with effect from the academic year 2005-2006)



# REVISED SYLLABUS FOR T Y B Sc Microbiology 2005-06 Onwards

The syllabus will come into effect from the academic year 2004-05.

Students opting for 6 Units of Microbiology (Major) at T Y B Sc level will study Papers I, II, III, IV of 100 marks each and 4 practicals based on these papers of 50 marks each.

Students opting for 3 Units of Microbiology at T Y B Sc level will study Papers I & II of 100 marks each and 2 practicals based on these papers of 50 marks each.

## Paper wise Units Summary

	Paper I	Paper II	Paper III	Paper IV
Title	<i>Genetics, Molecular Biology and Virology</i>	<i>Medical Microbiology, Chemotherapy and Immunology</i>	<i>Microbial Biochemistry</i>	<i>Bioprocess Technology</i>
Unit 1*	I. Foundation of Genetics [A, B, C, D]	I. Medical Microbiology [A-1 to A-5 & B]	I Microbial Metabolism [A to C]	I. Microbial Technology [A, B, C, D-1,2]
Unit 2*	I. Foundation of Genetics [E & F]	I. Medical Microbiology [A-6] II Chemotherapy	I Microbial Metabolism [D to G]	I Microbial Technology [D-3, E, F]
Unit 3*	I. Foundation of Genetics [G, H, I, J]	III. Immunology [A]	II Bioenergetics III Regulation V Photosynthesis	II. Applications of Principles [A]
Unit 4*	II Cell Biology III Virology	III. Immunology [B & C]	IV Solute transport VI Bioluminescence VII Biostatistics VIII Bioinformatics	II. Applications of Principles [B] III Bio-Instrumentation

- Note: Each Unit is of 30 lectures



Paper I - Topic Index				Unit
I	Foundations of Genetics			90
	A.	Introduction	[2]	Unit 1
	B.	Chromosome structure	[5]	
	C.	Genetic code	[5]	
	D.	Replication of DNA	[18]	
	E.	Genetic recombination	[15]	Unit 2
	F.	Genetic change	[15]	
	G.	Modification of genetic material :	[8]	Unit 3
	H.	Regulation of gene expression	[8]	
	I.	Recombinant DNA technology	[8]	
	J.	Population Genetics	[6]	
II	Cell Biology			20
III	Virology			10

## I. Foundations of Genetics

[90]

### A. Introduction

(02)

1. Review of relevant topics studied at FY & SY level: Mendelian genetics, Genetic information, DNA structure & function (for ensuring continuity of the subject, objective / subjective test may be conducted for checking retention and preparedness of students)
2. Branches of Genetics: Classical, Molecular, Population, Quantitative, Transmission & Evolutionary Genetics
3. Model organisms in the study of genetics
4. Applications of Genetics in medicine, forensics, agriculture and industry

### B. Chromosome structure

(05)

1. Physical properties, organization of DNA in chromosomes, methods used for study
2. Prokaryotic (Bacterial) chromosome:
  - i. Circularity,
  - ii. One replication origin,
  - iii. Basic proteins in bacterial chromosome
3. Eukaryotic chromosome
  - i. Physical properties, concept of linkage groups, linearity of the chromosome
  - ii. chromatin structure, euchromatin, heterochromatin
  - iii. role of histones & non histone proteins
  - iv. Structure of condensed chromatin
  - v. nucleosomes, centromere, kinetochores, telomeres,
4. Differences in the chromosomal structure of prokaryotic, eukaryotic cells and viruses

### C. Genetic code:

(05)

1. Historical perspectives- deciphering the genetic code
2. Terminology: gene, cistron, coding & anticoding strand, open & blocked reading frame, sense codons and non-sense codons, correspondence of sense codons with t-RNA molecules



3. Features of the genetic code: triplet nature, degeneracy, universality, non-overlapping, comma less, directional nature of the code, wobble hypothesis
4. Universality of the genetic code & exceptions to code, (listing different code tables)

- D. Replication of DNA in bacteria, viruses and plasmids (18)
1. Replication of bacterial chromosome.
    - i. Historical perspective, semi-conservative and bidirectional nature of replication
    - ii. Replication of circular double helical DNA, Theta model of replication (J. Cairns experiment) sigma model of replication (in conjugation)
    - iii. Use of origin, primer, leading & lagging strands, Okazaki's fragments
  2. Replication of plasmid DNA - F plasmid
  3. Enzymes associated with chromosome replication, their role and significance, (primase, helicase, topoisomerase, DNA polymerases, ligases, SSB proteins, telomerases, reverse transcriptase)
  4. Differences in DNA replication process in prokaryotic and eukaryotic cells, role of mitotic cyclins in eukaryotes
  5. Replication of DNA and RNA as genetic material in bacteriophages
    - i. mechanism of replication in  $\Phi$ x 174 phage
    - ii. MS2 phage - DNA intermediates, significance of RNA replicase,
  6. Replication of animal viruses - The process mechanism and model diagram of the replication process of:
    - Positive Strand RNA virus replication: Polio Virus
    - Negative Strand RNA virus replication: Influenza virus
    - DNA animal virus replication: Herpes simplex

- E. Genetic recombination (15)
1. General consideration
    - i. Terminology: recombination, exogenote, endogenote, genetic markers, zygote and merozygote.
    - ii. Fate of exogenote and endogenote
    - iii. Types of recombination: homologous, site-specific, illegitimate
    - iv. Integration of exogenote and endogenote,
    - v. Heteroduplex formation in transformation, fate of heteroduplex, ( correction, replication), Holliday model for double stranded molecules.
  2. Study of transformation
    - i. Definition, significance of transformation in nature,
    - ii. Transformation process in *Streptococcus pneumoniae*, *Haemophilus influenzae*, transformation of plasmids
    - iii. artificial transformation of plasmids and its significance
  3. Transfection: principle and significance with respect to phage DNA and bacteria and yeast
  4. Conjugation
    - i. Discovery of conjugation in bacteria
    - ii. F plasmid : map of plasmid and functions of the major genes
    - iii. concept of  $F^+$ ,  $F'$ , and Hfr strains
    - iv. mechanism of conjugation
    - v. Mapping genomes by conjugation (Wolman and Jacob's expt.)
    - vi. primary and secondary F strains
    - vii. Sexduction and its significance
    - viii. Solving problems based on recombination in bacteria



5. Transduction in bacteria
  - i. discovery, generalized transduction & specialized transduction,
  - ii. concept of defective and helper phages in specialized transductions
  - iii. abortive transduction, phage conversions
  - iv. use in gene mapping
6. Transposons
  - i. Historical perspective
  - ii. Insertion sequences, composite element and Complex transposons
  - iii. Structure and properties of transposons
  - iv. Mechanism of transposition. Cointegrate formation, role of transposase and resolvase
  - v. Significance of transposition in mutations, phase variation, conjugation, expression of silent genes, etc.

F. Genetic change

(15)

1. Introduction, role in evolution
2. Genotype, phenotype, locus, allele
3. Mutation: Spontaneous versus adapted mutation theory, concepts of point mutation, frame shift mutation, macro lesion, induced mutations, base pair substitution, transversions, transitions, mis-sense mutation, non-sense mutation, silent mutation, frame shift mutations, leaky mutation and non-leaky, conditional lethal mutation, pleiotropic mutations, cryptic mutation, reversion of mutation-true and pseudo reverse mutations
4. Mutagenesis:
  - i. Concept of mutagen, types of mutagens
  - ii. Hot spots, mutator genes
  - iii. Principle and mechanisms with illustrative diagrams for:
    - a. Chemical mutagens
      - base analogue, Nitrous acid, hydroxyl amine induced base pair substitution,
      - frame shift mutation induced by intercalating agents
      - alkylating agents and their multiple effects, their use in selective mutagenesis
    - b. Physical mutagens
      - UV and ionizing radiations
    - c. Biological mutagens- transposons, Mu phage
  - iv. Selection and detection of Mutants
 

Selection based on:

    - relative growth using sib selection & replica plating techniques
    - relative survival –using penicillin, 8 –aza guanine
    - Visual detection using tetrazolium salts, iodine
  - v. Phenotypic lag, effect of mutations on phenotype in bacteria
  - vi. Mutations in bacterial viruses, phenotypic mixing.
  - vii. Genetic complementation test.
  - viii. Ames test

G. Modification of genetic material :

(08)

1. Restriction and modification of nucleic acids
  - i. restriction endonucleases and modification methylases
    - Types, role and significance.
2. Principle and mechanism of repair of DNA: light repair, excision repair, DNA glycosylase mediated repair, repair of alkylation damage, mismatch repair, recombinational repair, and SOS repair



- H. Regulation of gene expression (08)
1. Regulation in bacteria
    - i. Operon model – criteria for negative / positive types and inducible / repressible types
    - ii. Examples of each group: negative control: lac operon, tryptophan operon; Positive control: Catabolite repression
  2. Regulation of lytic and lysogenic life cycle in bacteriophage  $\lambda$

- I. Recombinant DNA technology (08)
1. Types of vectors: Plasmids, cosmids, phages, phagemids, shuttle vectors; their applications, advantages and disadvantages of each
  2. Amplification of recombinant DNA using PCR technique.
  3. Introduction of foreign gene into vector- use of restriction endonucleases DNA polymerase, reverse transcriptase, ligases, etc.
  4. Introduction of recombinant DNA into recipient cells
  5. Screening and selection methods for identification and isolation of recombinant cells
  6. Applications of recombinant DNA technology

- J. Population Genetics (06)
1. Genetic structure of population Genotypic and allelic frequencies
  2. Introduction to Hardy- Weinberg Law
  3. Genetic variation in natural Population: Model of genetic variation, measurement of genetic variation by protein electrophoresis
  4. Change in genetic structure of population: Mutation, genetic drift, migration and natural selection

## II. Cell Biology

[20]

- A. Surface structures of the cell (08)
1. Cell wall (04)
    - i. Structure and function in yeast, plant and fungal cells
    - ii. Differences in the cell wall of prokaryotes and eukaryotes
  2. Cytoplasmic membrane: (04)
    - i. Bilayer nature
    - ii. Fluid Mosaic Model
    - iii. significance of membrane fluidity
    - iv. Factors influencing membrane fluidity
    - v. Functions of the cytoplasmic membrane
- B. Cytoskeleton – Structure and function of microtubules, microfilaments and intermediate filaments (02)
- C. Structure and Function of Membrane bound organelles (10)
- |                          |                                  |
|--------------------------|----------------------------------|
| 1. Nucleus               | 5. Vacuoles                      |
| 2. Endoplasmic Reticulum | 6. Vesicles                      |
| 3. Golgi Bodies          | 7. Peroxisomes                   |
| 4. Lysosomes             | 8. Mitochondria and Chloroplasts |



- A. Viral architecture (03)
1. Capsid, viral genome, envelope, viral symmetries,
  2. Structure of T4 phage, Myxo virus, Vaccinia virus, Rabies virus and AIDS, TMV
- B. Viral Cultivation and Assay (04)
1. Bacteria viruses
  2. Plant viruses
  3. Animal viruses – Chick embryo cultivation, animal inoculation, Animal tissues culture
- C. Viral Classification (03)
1. Criteria of viral classification,
  2. Tabulation of bacterial, plant and animal viral classification
  3. Baltimore scheme of classification

### Text Books

1. Alberts, Johnson, Lewis, Raff, Roberts, Watson, Molecular Biology of the Cell (2002), 4<sup>th</sup> Edition, Garland science
2. Fairbanks & Andersen, Genetics (1999), Wadsworth Publishing company. Brookes/ Cole Publishing Company
3. Freifelder D., Essentials of Molecular Biology (1985) Narosa Publishing House
4. Lewin, Genes VII (2000), Oxford University Press
5. Lodish, Berk, Zipursky et al, Molecular Cell Biology (2001), 4<sup>th</sup> Edition, W. H. Freeman and Company.
6. Madigan M. T., Martinko J. M., Parker J., Brock Biology of Microorganisms, (1997) 8<sup>th</sup> edition, Prentice Hall International
7. Russell, Genetics, 6<sup>th</sup> Edition, (2001) The Benjamin / Cummings Publishing Company Inc
8. Stanier, Ingraham et al, General Microbiology (1992), 5<sup>th</sup> Edition, Macmillan Education Ltd.
9. Tamarin, Principles of Genetics (2002), 7<sup>th</sup> edition, Tata McGraw-Hill Publishing Company
10. Davis B. D., Dulbaeco, R., Eisen, N. H. & Ginsberg, H.S. (1980), Microbiology, 3rd edition, Harper & Raw Publication.
11. Watson
12. Luria

### Reference Books

1. Benson, Microbiological applications – Laboratory Manual in General Microbiology (2002), International Edition, McGraw Hill Higher Education
2. Gardner, Simmons, Snustad, Principles of Genetics, VIII edition, (1991), John Wiley and Sons
3. Glick and Pasternak, Principles and applications of recombinant DNA (2003), First Indian Reprint, ASM press
4. Hartl & Jones, Genetics – Analysis of genes and genomes (2001), 5<sup>th</sup> Edition, Jones and Bartlett Publishers
5. Weaver and Hedrick, Genetics (2002), 4<sup>th</sup> Edition, Wim. C. Brown Publishers.



## Practical Syllabus Based On Paper I

1. Enrichment, isolation and enumeration of phages from sewage
2. To study the effect of U. V. Light on *E.coli*
3. Isolation of Antibiotic resistant organisms ( Penicillin or streptomycin)
4. Gradient plate technique for isolation of dye / drug resistant mutants
5. Isolation of plasmids by miniprep method, separation by agarose gel electrophoresis, and visualization by U. V fluorescence,
6. Transformation of *E coli*
7. Isolation and purification of DNA from *E coli* / onions
8. Isolation of mitochondria and chloroplasts from germinated moong seeds / plant leaves
9. Isolation of auxotrophic mutants ( Vit. B12) using Replica plate technique

### Demonstrations / Visits / Videos / CD's / Project Reports

1. Observation of video / CD demo of DNA replication in *E.coli*
2. DNA microarrays and their use in analysis of gene expression
3. Site directed mutagenesis
4. DNA Fingerprinting
5. Current Status of recombinant DNA technology
6. Ti plasmid in agriculture
7. Retrovirus replication
8. DNA fingerprinting
9. Current status of Recombinant DNA Technology in India.
10. Solving problems on genetic code
11. Solving problems on Population Genetics

Paper II - Topic Index					Unit	
I	Medical microbiology			[50]	30	Unit 1
	A.	Specific infections (A-1to A-5)	[30]			
	B.	Quality assurance in diagnostics	[10]			
II	Chemotherapy			[20]	30	Unit 2
I	Medical microbiology					
	A	Specific infections (A-6)	10			
III	Immunology			30	Unit 3	
	A.	Fundamentals of the immune system	[20]			
	B.	The adaptive immune response	[10]			
	C.	Immune system in health and disease	[20]	30	Unit 4	
Total					120	

## I. Medical microbiology [50]

### A. Specific infections (40)

**Note:** All diseases of each system to be taught together with emphasis on

- Etiology & Transmission
- Pathogenesis & Clinical manifestations
- Lab diagnosis & Treatment and prevention

- Respiratory tract infections (06)
  - Upper respiratory tract: Streptococcal Pharyngitis, Diphtheria Common cold, Oral Candidiasis
  - Lower Respiratory Tract: Tuberculosis, Bacterial pneumonia, Influenza.
- Urinary tract-infections (03)
  - List of organisms encountered in the urinary tract as per reference (Mims)
- Sexually transmitted infections: Syphilis, Gonorrhea, AIDS (04)
- Gastro- intestinal infections (12)
  - Infectious diseases
    - Bacterial: *E.coli*, *Salmonella*, *Shigella*, *Vibrio*, *Campylobacter*
    - Viral: *Rota viruses*
    - Protozoal: *E.histolytica*
  - Food Poisoning; Staphylococcal, Botulism
- Central nervous system infections (05)
  - Bacterial; Meningitis, Tetanus
  - Viral; Meningitis, Encephalitis- Tabulation and pathogenesis only
  - Viral: Poliomyelitis, Rabies



6. Skin infections (10)
- Bacterial; Pyogenic staphylococcal, streptococcal,
  - Mycobacterial disease; Leprosy
  - Vector borne infections
  - Rickettsial infections: (Tabulations)
  - Protozoal infections: Malaria
  - Fungal: Dermatophytosis, Candidiasis

B. Quality assurance in diagnostics (10)

1. Definition and goals of Quality Assurance, Quality Assessment and Quality Control; Role in accuracy, safety / risk management (03)
2. QA monitors, goals regarding specimens, test utilization, reports, and user perceptions (02)
3. QC guidelines regarding personnel, policy and procedure manuals, records and reports, media, reagents, stains and equipment, proficiency testing, test verifications and validation. (05)

II. Chemotherapy [20]

A. Basics of Chemotherapy (02)

1. The history and development of chemotherapy
2. General properties of antimicrobial agents
3. Attributes of an ideal antimicrobial agent

B. Principal groups of anti bacterial agents and mechanism of action (11)

1. Inhibitors of cell wall
  - i. Beta lactams - Penicillins, Cephalosporins
  - ii. Glycopeptides - Vancomycin
  - iii. Cycloserine
  - iv. Bacitracin
2. Inhibitors of protein synthesis
  - i. Aminoglycosides – Streptomycin, Gentamycin, Amikacin
  - ii. Tetracyclines
  - iii. Chloramphenicol
  - iv. Macrolides – Erythromycin
  - v. Lincosamides - Lincomycin
3. Inhibitors of Nucleic acid synthesis
  - i. Inhibitors of synthesis of precursors – Sulphonamides, Trimethoprim
  - ii. Inhibitors of DNA replication – Quinolones
  - iii. Inhibitors of RNA polymerase – Rifamycin
4. Inhibitors of Cyto plasmic membrane function – Polymyxins

C. Anti- mycobacterial, Antifungal & Antiviral agents – tabulation (01)

D. Drug resistance: Origin, mechanisms and transmission (01)

E. Selection and testing (05)

1. Factors influencing the selection of drugs (dose, route, toxicity, combined therapy, etc.)
2. Special issues in susceptibility testing: Beta lactamase, oxacillin and vancomycin resistant staphylococci
3. Testing of antibiotics: Checkerboard assay, Schlichter's Test, E-test

### III Immunology

[50]

- A. Fundamentals of the immune system (20)
  1. Maturation of the Lymphoid cells: T, B, and Null cells (05)
    - i. Surface receptors and markers
    - ii. Ontogeny and Maturation
    - iii. Immunoglobulin Superfamily (diagrams)
  2. Antigen Presenting Types and tissue location cells (02)
  3. Major Histocompatibility Complex (05)
    - i. General organization
      - Location and Function of MHC Regions
      - MHC haplotypes
    - ii. MHC molecules and genes
      - Structure of class I molecules
      - Structure of class II molecules
      - Organisation of class I and class II genes
      - Peptide binding by MHC molecules
      - Polymorphism of class I and class II molecules and functional relevance
      - Class III molecules
      - T cell antigen receptor and the MHC molecules
      - Control of Immune responsiveness by MHC genes
      - Tests for MHC specificity
  4. Cytokines (02)
    - i. Properties of cytokines
    - ii. Functions of cytokines
    - iii. General structure of cytokines receptors
    - iv. Cytokine secreted by Th1 and Th2 subsets (Table)
  5. The Complement system (06)
    - i. Introduction to terms
    - ii. The Complement components and notations
    - iii. Complement activation
      - Classical pathway
      - Alternative pathway
      - Lectin pathway
      - Terminal sequence
    - iv. Regulation of Complement pathways
    - v. Biological consequences of Complement activation
    - vi. A list of Complement binding receptors and their functions
- B. The adaptive immune response (10)
  1. Antigen processing and presentation (01)
 

Two pathways for processing and presentation

    - i. The cytosolic pathway
    - ii. The endocytic pathway

(Overview from diagrams general steps involved)



2. Th cell activation and differentiation (01)
  - i. Activation
    - TCR coupled signaling pathways - general idea
    - Co-stimulatory signal - differences amongst APCs
    - Super antigen induced Tcell activation
  - ii. Differentiation
    - Generation of Effector and Memory Tcells
    - Cell death of Tcell population
    - Function of peripheral  $\gamma \delta$  Tcells
3. B-cell activation and proliferation (02)
  - i. Thymus dependent and independent antigens
  - ii. General idea of activating signals
  - iii. Role of Th cells in Humoral response
    - Formation of T-B conjugate
    - CD 40 / CD 40L interaction
    - Th cell cytokine signals
4. The Humoral response (02)
  - i. Primary and Secondary responses
  - ii. Induction of Humoral response
  - iii. Germinal centres and antigen induced B-cell differentiation
  - iv. Organization and expression of immunoglobulin genes
    - Multigene organisation of immunoglobulin genes - light and heavy chain (diagrams)
    - Gene rearrangement
    - Affinity maturation and somatic hypermutation
    - Class switching
  - v. Generation of plasma cells and memory B cells
    - Expression of immunoglobulin genes
    - Synthesis assembly and secretion of immunoglobulin
  - vi. Evaluation of Humoral response
5. Cell mediated effector responses (02)
  - i. Cytotoxic T cells
    - Generation
    - Target destruction
  - ii. Natural killer cells and killing mechanism
  - iii. ADCC
  - iv. Experimental assessment of cell mediated cytotoxicity
6. Theories of antibody formation and diversity (01)
7. Monoclonal antibodies (02)
  - i. Preparation
  - ii. Applications
  - iii. Engineered antibodies
- C. Immune system in health and disease (20)
  1. Antigen-Antibody Reactions in vitro (03)
    - i. Passive Agglutination and Agglutination inhibition
    - ii. Complement Fixation
    - iii. Labelled Reactions – RIA, ELISA, Immunofluoresence,
    - iv. Western Blot, Immunoelectron Microscopy
    - v. In vitro, &in vivo Toxin-Antitoxin assay

2. Immune response to infectious diseases - Tabulation (01)  
Viral, Bacterial, Protozoal & helminthes infections
3. Vaccines (07)
  - i. Types of immunization procedures
  - ii. Passive immunization
  - iii. Active immunization
    - Herd immunity
    - Designing vaccines for active immunization
    - Whole organism vaccines
  - iv. New approaches
    - Purified macromolecules as vaccines - polysaccharide , toxoid
    - recombinant antigen vaccine
    - Recombinant vector vaccines
    - DNA vaccines
    - Synthetic peptide vaccines
    - Multivalent subunit vaccines
    - Antiidiotypic vaccine
  - v. Route of vaccines administration and use of adjuvants
  - vi. Vaccination schedules
  - vii. Failures in vaccination and benefits
4. Immune haematology (04)
  - i. Blood groups of humans
    - ABO and Lewis system
    - Secretors and non-secretors
    - Rhesus system
    - Other blood group systems
  - ii. Blood tranfusion
    - Blood typing
    - Major and minor cross matching
    - Transfusion reactions
  - iii. Haemolytic Diseases of the Newborn and Coombs test
  - iv. Tests for infections in blood
5. Hypersensitivity (03)
  - i. Coombs and Gell classification
  - ii. Tyoes of hypersentistivity ; mechanisms and manifestations - Type I - IV
6. Autoimmunity (01)
  - i. Definitions of Immune tolerance and Immune suppression
  - ii. Definition of auto immunity
  - iii. List of disorders
  - iv. Possible mechanisms
  - v. Treatment
7. Defects in the immune system - A list with examples (01)
  - i. Defects in phagocytosis
  - ii. Primary immuno deficiencies
  - iii. Secondary immuno deficiencies
  - iv. Complement deficiencies



## Text Books

1. Ananthnarayan, Medical Microbiology 6<sup>th</sup> edition
2. Greenwood, Slack, and Peutheren, 1997, Medical Microbiology, 15th edition Churchill Livingstone Publication
3. Jawetz et al, Review of Medical Microbiology
4. Konemann, E.W., Allen, S. D., Janda, W.M., Schreckenberger, P. C. & Winn W. C. Jr., 1997 Color Atlas and Textbook of Diagnostic microbiology, 5th ed, Lippencott publications
5. Bailey & Scott, Diagnostic Microbiology 8th edition
6. Mims, Playfair, Roitt, wakelin, William, Medical Microbiology 1993, Mosby Europe Ltd.
7. Collee, Fraser, Marman and Cimmon, 1998, Mackie and McCartney, Medical Microbiology, Churchill Livingstone Publications.
8. Hugo & Russell, Pharmaceutical Microbiology
9. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne; Kuby Immunology, 1999, 4th edition, W.H. Freeman and Company, New York
10. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne; Janis Kuby, Immunology, 2002, 5th edition, W.H. Freeman and Company, New York
11. Sulabha Pathak, Urmi Palan, Immunology, 1997, Pareen Publications
12. Chatterjee, Parasitology
13. Talaro and Talaro : Foundations in Microbiology, 3rd / 4th Edition, 2000 McGraw Hill
14. Prescott, Harley, Klein: Microbiology, 4th / 5th Edition, 1999, McGraw Hill
15. Bhatia, R (19??), "Quality assurance in microbiology", CBS Publications, New Delhi.

### For Practicals

1. The HI-MEDIA MANUAL for microbiology laboratory practice, 1998
2. Isenberg, H., Essential Procedure Of Clinical Microbiology, 1997, ASM press
3. Stanford, Davidson, 1997, Todd's Clinical diagnosis and management by laboratory methods, 17th edition, John B Henry, W. B. Saunders company
4. Konemann, E.W., ALLEN, S.D., JANDA, W.M., Schreckenberger, P. C. & Winn W.C. Jr., 1997 Color Atlas and Textbook of Diagnostic microbiology, 5th ed, Lippencott publications
5. Godkar P.B. (1994), Textbook of medical lab technology, Bhalani publishing House

### Reference Books

1. Charles A Janeway Jr, Paul Travers, Mark Walport, Mark J Shlomchik. Immunobiology, 2001, 5th international edition, Garland publishing, member of Taylor and Francis group
2. Ian R Tizard, Immunology, An introduction, 1995, 4th edition, Saunders College Publishing, Harcourt Brace College Publishers

### INTERNET SITE

- 1) [www.whfreeman.com/immunology](http://www.whfreeman.com/immunology)



## Practical Syllabus Based On Paper II

1. Schematic/ diagrammatic representation of each system as per the theory syllabus (Respiratory, Urinary, Gastro-intestinal, Central Nervous Systems, Skin)
2. "Diagnostic cycle" of any one infection of each of the above systems (viz., In upper respiratory tract : Pharyngitis)
3. Samples of various forms/procedures used for diagnostic tests, eg. Request forms, QC slips, for samples, reagents, stains, media, equipment validation, Test-Reports, (Results, Panic report, Alert report) to be drawn or attached in the journal.
4. Tabulation of :
  - a. Types of samples , containers, specimens, w.r.t. the symptoms/ infections.
  - b. Transport media w.r.t. samples/suspected pathogen.
  - c. Collection and Processing of samples in various infections.
  - d. Primary isolation of suspected pathogens in different infections w.r.t. pathological samples
  - e. Rapid tests for identification of pathogens, eg. oxidase, catalase, stainings ( Acid fast, Metachromatic granules , Capsule ) , Germ tube formation
  - f. Minimum biochemical media for identification of the pathogens listed in the syllabus i.e. *S. aureus*, *S. pyogenes*, *Corynebacterium diphtheriae*, *E. coli*, *Klebsiella sp.*, *Salmonella sp.*, *Shigella sp.*, *Vibrio sp.*, *Proteus sp.*, *Pseudomonas sp.*
  - g. List of samples to be used with the above : URT: Nasal swab, Throat swab, LRT : Sputum, Oral cavity : oral scrapings , Skin: Skin scrapping , pus , GIT : Faeces, rectal swab, UTI : Urine ,Bacteraemia : Blood, CNS : CSF.
5. Case study and problem solving for identification of the pathogen and antibiotic sensitivity testing with reference to each of the infections (Include approach writing, suspected organisms, requirements for the identification tests and their justification rapid tests AST Reports.)
6. Perform Quality control tests of media, reagents, strains and equipment used in the syllabus.
7. Kirby-Bauer method and Stokes method for AST
8. Synergistic activity of antibiotics
9. E test
10. Agar cup method for determination of antibiotic levels in body fluids(serum)
11. Detection of  $\beta$ -lactamase producer by Acidometric/ Iodometric method
12. AST of an antifungal agent
13. Determination of Isoagglutinin titre
14. Coombs test - direct method
15. Compatibility test - cross matching
16. Sero diagnosis of syphilis - VDRL qualitative and quantitative (Demonstration)
17. Immuno diffusion – SRID
18. Separation of lymphocytes and staining (Demonstration)
19. Pregnancy test – ELISA (Demonstration)
20. Rheumatoid arthritis test (Demonstration)
21. Preparation of Typhoid vaccine and sterility checking



## Demonstrations / Visits / Videos / CD's / Project Reports

1. Effect of Seasonal Variations on infections
2. Role of fomites in the spread of infections
3. Rapid identification kits for pathogens
4. Modern diagnostic methods
5. New and emerging diseases
6. Drug designing
7. New generation Antibiotics
8. Genetically engineered antibodies in therapy
9. Drug Allergies
10. Immunofluorescence - ANAFLUOR
11. Tests of allergy - estimation of IgE in humans by RIA or ELISA
12. Stem cells - clinical use and potential
13. Therapy with interferon
14. DNA Vaccines
15. Experimental animal models in research

Paper III - Topic Index			Unit
I	Microbial Metabolism (A to C)	30	Unit 1
I	Microbial Metabolism (D to G)	30	Unit 2
II	Bioenergetics	12	Unit 3
III	Regulation	12	
V	Photosynthesis	06	
IV	Solute transport	10	Unit 4
VI	Bioluminescence	02	
VII	Biosstatistics	08	
VIII	Bioinformatics	10	
Total		120	

### I. Microbial Metabolism

[60]

(With structures and enzymes wherever applicable)

#### A. Methods of studying metabolism

(02)

1. Use of biochemical mutants, Isotopic labeling, sequential induction technique
2. Modern methods based on biochemical genetics, molecular biological and computational techniques, concept of metabolome and its uses in the study of metabolism

#### B. Metabolism of carbohydrates

(22)

##### 1. Catabolism

- i. Breakdown of polysaccharides – glycogen, starch, cellulose
- ii. Breakdown of oligosaccharides – lactose, maltose, sucrose
- iii. Utilization of monosaccharides – fructose, galactose, mannose
- iv. Other pathways :
  - a. Glycolysis (EMP)
  - b. HMP Shunt
  - c. ED pathway
  - d. Phosphoketolase pathway (pentose & hexose phosphoketolase), Bifidobacterium pathway
  - e. Other modes of fermentations in microorganisms: alcohol, mixed acid, butanediol, butyric acid, butanol-acetone, propionic acid ( randomizing & non-randomizing pathway)
  - f. Citric acid cycle, anaplerotic reactions, glyoxylate bypass.
  - g. Amphibolic pathways: role of EMP and TCA cycle

##### 2. Anabolism

- i. Gluconeogenesis
- ii. Biosynthesis of glycogen
- iii. Peptidoglycan biosynthesis

#### C. Nucleic acid metabolism

(06)

1. Synthesis of Nucleotides
  - i. Synthesis of Ribonucleotides
  - ii. Synthesis of Deoxyribonucleotides
2. Utilization of Exogenous Purines and Pyrimidines bases and nucleosides



(12)

D. Protein metabolism

1. Catabolism

- i. Metabolic fate of Amino acids (formation of intermediates of TCA cycle-schematically) <sup>3,6</sup>
- ii. Different types of catabolic reactions of individual amino acids
- iii. Fermentation of amino acids
  - a. Single amino acid-glutamic acid and alanine
  - b. Stickland reaction

2. Anabolism

- i. Amino acid biosynthesis (Tabulation of biosynthetic derivations of amino acid families)
- ii. Protein synthesis
  - a. Biosynthesis of RNA (Transcription).
  - b. Translation process

E. Lipid metabolism

(08)

1. Catabolism

- i. Oxidation of saturated fatty acids (Beta oxidation pathway)
- ii. Oxidation of propionic acid
- iii. Oxidation of saturated hydrocarbons (Omega oxidation)
- iv. Degradation of poly beta hydroxyl butyric acid

2. Anabolism

- i. Biosynthesis of straight chain even carbon saturated fatty acids
- ii. Biosynthesis of poly beta hydroxyl butyric acid
- iii. Fatty acid synthesis in *Clostridium kluveri* (Ethanol acetate fermentation)

F. Metabolism of Aromatic compounds

(04)

1. Catabolism of aromatic compounds to catechol and protocatechuic acid (schematic only)
2. Ortho and meta cleavage of catechol and protocatechuic acid.

G. Inorganic Metabolism

(06)

1. Assimilatory pathways: Molecular Nitrogen, Ammonia, Nitrate and sulfate
2. Dissimilatory pathways: Nitrate and sulfate reduction (anaerobic respiration)
3. Oxidative pathways (Lithotrophs) Enlist- Hydrogen, Carbon-monoxide, Ammonium, Nitrite Sulfur and Iron oxidizing microorganisms, and Products formed

II. Bioenergetics

[12]

A. Electron transport chain in organotrophs

(03)

1. Eukaryotic (Mitochondrial) and prokaryotic (*E.coli* and *Azotobacter vinelandii*) electron transport chain, its components & functions
2. Electron transport chain in lithotrophs (*Thiobacillus ferrooxidans*) (Only schematic representation)

B. Generation & Utilization of proton motive force

(04)

1. Structure & function of ATP synthase
2. Generation by :
  - i. Oxidation-reduction reaction (ETC)
  - ii. Other mechanisms: Sodium transport decarboxylases, Oxalate formate exchange, and End-product efflux
3. Utilization for: Solute uptake and ATP Synthesis



- C. Oxidative phosphorylation- mechanism (03)  
 1. Chemical coupling hypothesis  
 2. Conformational coupling hypothesis  
 3. Chemiosmotic coupling hypothesis
- D. Calculation of energetic of : (02)  
 EMP Pathway, TCA cycle and Beta oxidation of palmitic acid

### III. Regulation [12]

- A. Cellular control mechanism acting at various levels of metabolism (01)  
 B. Regulation of enzyme activity (Enzyme inhibition/activation) (03)  
 1. Mechanism of End-Product Inhibition  
 2. Patterns of regulation-- End-Product Inhibition in branched pathways, Isofunctional enzymes, concerted feedback Inhibition, sequential feedback inhibition, Cumulative Feedback Inhibition, Combined activation and inhibition
- C. Regulation of enzyme synthesis (Enzyme induction/repression) (04)  
 1. Mechanism of control of transcription  
 i. By DNA- Binding proteins  
 • Lac operon (Negative control of enzyme induction)  
 • Ara operon ( Positive control of enzyme induction)  
 • Catabolite repression  
 ii. By Attenuation  
 • Trp operon ( End-Product Repression)  
 • Enzyme Repression in Branched Biosynthetic Pathways  
 iii. By Multiple Sigma Factors
2. Covalent modification of regulatory of enzymes (02)  
 Glutamate synthetase system of *E.coli*
- D. Regulation of metabolic pathways (02)  
 EMP pathway and TCA cycle

### IV. Solute transport [10]

- A. Solute transport process  
 1. Methods used in studying solute transport (01)  
 2. Types and mechanisms of solute transport (04)  
 i. Passive diffusion  
 ii. Carrier- mediated transport processes  
 • Facilitated diffusion  
 • Active transport  
 - Shock sensitive system  
 - Primary active transport (along with bioenergetics)  
 - Secondary active transport  
 iii. Group translocation
- B. Molecular mechanism of active transport of solute (04)  
 1. Carrier conformational change  
 2. Dehydrogenase coupled active transport  
 3. Ion gradient mediated active transport
- C. Summary of membrane transport mechanisms in *E.coli* (01)  
 (only diagram and examples)



## V. Photosynthesis

[6]

- A. Early studies on photosynthesis (01)
  - 1. General characteristics of bacterial photosynthesis, bacterial phototrophs (enlist)
  - 2. Light and Dark reactions
  - 3. Hill reaction
- B. Photosynthetic apparatus (01)
  - 1. Antenna of light harvesting pigments
  - 2. Photochemical reaction center
  - 3. Photosynthetic ETC
- C. Electron flow in bacterial photosynthesis (02)
  - 1. Cyclic photophosphorylation
  - 2. Non-cyclic photophosphorylation
- D. Path of carbon (02)
  - 1. Reductive pentose phosphate cycle (Calvin cycle)
  - 2. Reductive TCA cycle
  - 3. C4 Pathway

## VI. Bioluminescence

[2]

## VII. Biostatistics

[8]

- A. Experimental errors: (02)
  - 1. Systemic and random errors, avoidable and unavoidable errors
  - 2. how to reduce errors in an experiment by using experimental designing techniques
  - 3. Difference between accuracy and precision
- B. Definition and Calculation of Central Tendencies and their utility in data processing: (02)
  - 1. Mean, Mode, Median
  - 2. Standard deviation
  - 3. Variance
  - 4. Coefficient of variation
- C. Illustrative statistical tests used to establish reliability of experimental data (02)
  - i. Q test
  - ii. Students "t" test
  - iii. F test
  - iv. Confidence Limits and confidence interval
- D. Application of correlation coefficient and linear regression to experimental Data (02)

## VIII. Overview of Bioinformatics

[10]

- A. Introduction to bioinformatics: (01)
  - Definition of bioinformatics, genomics, proteomics, functional genomics, Computational biology
  - As an extension of molecular biology / essential tool of modern biology
- B. Role of Biology, Mathematics, Statistics, Information technology and Computer Science in Bioinformatics development, role of internet (01)
- C. Nature of biological information - From Central dogma of molecular biology to Central Paradigm of Bioinformatics (01)
- D. Sequence alignment - basis of and general principles involved, global / local, tools available like BLAST (03)

- E. Types, properties and applications of biological databases, with suitable illustrative examples (GeneBank at NCBI, PDB, Swiss Prot at EBI) (03)
- F. Illustrative applications of bioinformatics (02)
  - Predicting Structure, localization, function of proteins
  - Gene Expression analysis
  - Identification of essential genes
  - Phylogenetic analysis
  - Manufacture of designer drugs

### Text Books

1. Stanier, R. Y., Ingrahm, J. L., Wheelis, M. L., Painter, R. R., (1987) General Microbiology, 5<sup>th</sup> ed, The Macmillan press Ltd.
2. Stanier, R. Y., Adelberg, A. E., Ingrahm, J. L. (1980) General Microbiology, 4<sup>th</sup> ed, The Macmillan press Ltd.
3. Conn, E. E., Stumpf, P. K., Bruening, G. R. H, (1987) Outlines of Biochemistry, 5<sup>th</sup> ed., John Wiley & sons.
4. Gottschalk, G., (1985), Bacterial Metabolism, 2<sup>nd</sup> ed, Springer-Verlag
5. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 2<sup>nd</sup> ed, Oxford University Press.
6. Lehninger, A.L., (1990), Principles of Biochemistry, CBS Publishers & Distributors Pvt Ltd
7. Rose, A. H., (1980), Chemical Microbiology, 3<sup>rd</sup> ed, Butterworths.
8. Salle, A.J., Fundamental Principles of Bacteriology, 6<sup>th</sup> ed, Tata McGraw-Hill Publishing Co Ltd.
9. Wilson, K. and Walker, J. (1995) Practical biochemistry, Principles and techniques, 4<sup>th</sup> ed, Cambridge University Press.

### Reference Books

1. Voet, D. & Voet, J. G., (2004), Biochemistry, 3<sup>rd</sup> ed., John Wiley & Sons Inc
2. Zubey, G. L. (1996), Biochemistry, 4<sup>th</sup> ed. Wm. C. Brown Publishers
3. Zubey, G. L. (1995), Principles of Biochemistry, Wm. C. Brown Publishers
4. Metzler D. (2002:Vol1 & 2003:Vol2), "Biochemistry", Academic Press.



## Practical Syllabus Based On Paper III

1. Isolation of phenol degraders and estimation of residual phenol by 4-aminoantipyrine method.
2. Estimation of beta galactosidase activity in induced and non-induced cells of E-coli.
3. Glucose Estimation using enzymological technique (GOD/POD).
4. Protein estimation by Lowry's method.
5. Isolation of bioluminescent bacteria from fish.
6. SDS-PAGE of proteins of bacterial hydrolysate using egg white proteins as molecular weight markers (Group Expt, Demonstration)
7. Agarose Gel electrophoresis of DNA (Group Expt, Demonstration)
8. Separation of yeast and bacterial cells by using discontinuous sucrose gradient
9. Study of biochemical pathway and presence of end products or enzymes in characterization of microorganisms.
  - i. Detection of homo and mixed acid fermentative bacteria and their end products by paper chromatography.
  - ii. Detection of lysine decarboxylase enzyme
  - iii. Oxidative and fermentative utilization of glucose by microbes (Pseudomonas and Staphylococcus sp)
  - iv. Phosphatase activity detection – qualitative & quantitative
  - v. Detection of penicillinase activity
12. Biostatistics: To test the reliability of experimental data using
  - a. Student t test
  - b. F test
  - c. Q test

### Demonstrations / Visits / Videos / CD's / Project Reports

1. Understanding protein function from its structure & methods of study
2. Exploring the possible block present in the pathway of the auxotrophic mutants (amino acid) generated in Practical I (eg. using cross feeding technique for amino acid pathway)
3. Demonstration of Pathway tools & its use in compiling all data generated from metabolic and genetic study, demonstration of Ecosys and Metasys compiled using pathway tools
4. Demonstration of molecular modeling software – SPDBV or equivalent, viewing .pdb files (protein database format), Ramchandran Plot, modifying molecular structure.
5. Visiting Biochemistry / bioinformatics related Web sites like KEGG, NCBI, PDB and Swiss Prot for study of various tools and databases available.
6. Demonstration of protein structure viewers like SPDBV / ViewerLite / VMD (SPDBV tutorial at SwissProt)
7. Demonstration of sequence alignment using tools like BioEdit, BLAST tutorial at NCBI
8. Demonstration of Ptools as a data consolidation tool in the study of biochemical pathways of many living systems and related information
9. Demonstration of Protein Isoelectric focusing, 2D Gel and MS analysis
10. Demonstration of role of sequence analysis techniques in Biochemistry.
11. Demonstration of transport phenomena
12. Demonstration of tracer techniques in Biochemical pathway analysis.
13. Demonstration of working of ultra centrifuge
14. Demonstration of working of gel filtration (Sephadex) column

### Industrial / Research Laboratories Visit

Visit to research institutes and industrial research laboratory where these topics / instruments and other topics covered in the syllabus can be demonstrated.





Paper IV - Topic Index			Unit
I	Microbial Technology (A, B, C, D-1,2)	30	Unit 1
	Microbial Technology (D-3, E, F)	30	Unit 2
II	Applications of Principles of Industrial Microbiology 50		Unit 3
	A. Industrial Production	[30]	
	B. Dairy Microbiology	[12]	Unit 4
III	Bio Instrumentation	[18]	
Total		120	

## I. Microbial Technology [60]

- A. Industrial Strain improvement, Preservation of industrial strains, Fermentation Economics (07)
- B. Fermentation Equipments (08)
  1. Basic functions of a fermentation vessel, Construction of typical fermentor and its attachments and role in the process
  2. Deviation from the classical design – various approaches used for classification of fermentation vessel
    - i. Power Input for mixing (mechanical, hydrodynamic and pneumatic)
    - ii. Construction material used (glass, wood, steel, plastic, copper, concrete, etc)
    - iii. Scale of operation (Lab, Bench scale, pilot plant, production level)
    - iv. Mode of operation (Batch, semi-continuous, continuous, SSF)
    - v. Distribution of various known types or examples into each of the above groups (aerobic, acetator, cavitator, bubble-cap, air-lift, plugflow, Trickle filter, animal tissue culture reactors), illustrating typical constructional features and their importance in the specific processes, brief review of other supporting services or equipments used for process operations
- C. Raw Materials for fermentation process (03)
  1. Media Ingredients (02)
    - i. Air, water, list of typical Energy, C, N sources of industrial significance with examples of processes (see section IIA) in which used.
    - ii. Other ingredients used for buffering, precursors, steering agents, inducers, inhibitors, antifoam agents, trace elements
    - iii. Sources of industrial significance with examples of processes in which used
  2. Media Formulations (01)
    - i. Role of media ingredients in process control and costing
    - ii. Formulations of industrial significance with examples of processes (see section IIA in which used)
- D. Fermentation Process Considerations (22)
  1. Aseptic Process Operation- sterilization and sterility maintenance and containment
    - i. Need and Objectives (01)
    - ii. Approaches Employed (02)
      - a. Use of Pure Inoculum
      - b. Sterilization of medium and all materials added during process
      - c. Sterile vessels
      - d. Aseptic Operations – fermentation proper as well as product recovery
    - iii. Sterilization (03)
      - a. Theoretical considerations – defining industrial sterility, use of Del factor – linking time and temperature used to require sterility



- b. Practical aspects – sterilization of vessels, medium, air, external additives like acid, alkali, antifoams, steering agents, added during the process – examples of industrial significance from processes studied in section IIA
    - iv. Aseptic operations and containment during the process (01)
  2. Process Operations
    - i. Inoculum development methods, aseptic inoculation (01)
    - ii. Process parameter monitoring and control - pH, temperature, ingredient concentration, oxygen concentration, foam – online / offline analysis, inlet and exit gas analysis (02)
    - iii. Process Termination (01)
  3. Fermentation Product Recovery
    - i. Criteria for choice of recovery process (01)
    - ii. Biomass separation from fermentation media (02)
      - a. Precipitation
      - b. Cell aggregation and flocculation
      - c. Filtration, filter aids, plate frame and rotary vacuum filters
      - d. Centrifugation – batch, semi continuous, continuous
    - iii. Cell Disruption for intracellular products (01)
    - iv. Product recovery from mother liquor (04)
      - a. Solvent extraction and solvent recovery
      - b. Chromatographic methods
      - c. Crystallization
    - v. Whole broth processing (01)
- E. GMP and Quality Assurance in Industrial Microbiology (08)
  1. GMP (01)
  2. Quality Assurance in Industrial Microbiology (02)
    - i. Role of Quality Assurance systems in Industrial process
    - ii. Scope of activities handled by QC section – from raw material to finished products monitoring
  3. Microbiological assays: Principles and methods, Merits and Demerits of bioassays, sources of errors and their elimination (02)
  4. Hazard Analysis (01)
- F. Treatment of Industrial Wastes (02)
  1. Principles of physical, chemical and biological treatment process
  2. Treatment of Effluents from Distillery, Dairy and Antibiotic production units
- G. Industrial Biotechnology: (10)
  1. Impact of developments in molecular biology, recombinant DNA technology on Industrial Microbiological Processes.
  2. Examples: Antibiotics, Biopolymers, Biopesticides, Waste treatment, Industrial Enzymes, Animal cell and tissue culture technique
  3. Diagnostics (DNA probes), biosensors, biochips, protein product Enzymes, Bioplastic

## II. Applications of Principles of Industrial Microbiology [50]

- A. Industrial Production of (30)
  1. Beer, Wine, Industrial alcohol from molasses
  2. Vinegar – (Acetator Method)
  3. Penicillin, Streptomycin]

4. Vitamin B12 from Propionibacterium
5. Glutamic Acid
6. Amylases (Fungal) Production
7. Baker's and Brewer's yeast
8. Citric acid – Stationary culture
9. SCP: Yeast – Candida utilis, mushrooms – Agaricus bisporus, criteria and
10. safety
11. Biotransformation of Steroids (List of organisms and steroids transformed)
12. Biopesticides – Bacillus thuringiensis
13. Biofertilizers
14. Vaccines – General Manufacturing aspects and quality control
15. Fermented foods
  - i. Sauerkraut
  - ii. Bread
  - iii. Pickle
  - iv. Idli

#### B. Dairy Microbiology

(12)

1. Microbial flora of milk (02)
  - i. Normal and abnormal flora, their sources and changes induced by them
  - ii. Milk – Borne Pathogens
2. Processing and analysis of milk (04)
  - i. Collection of Milk, Platform test, Chilling
  - ii. Grading of Milk – ISI standards
    - a. Dye Reduction tests – Resazurin and MBRT test
    - b. DMC
    - c. SPC, LPC, Thermoduric Count, Thermophilic count, Psychrophilic count
    - d. Pasteurization of milk - HTLT, LTHT, Phosphatase Test
    - e. Packaging, Storage and Distribution of Milk, Shelf Life
3. Milk Products: General Production and Spoilage (06)
  - i. Long term preservation of milk – Preparation of milk powder and sweetened condensed milk, sterilized milk (tetra pack)
  - ii. Butter –
  - iii. Cheese – Types and production (Cheddar and Cottage)
  - iv. Yogurt – Types and production
  - v. Other traditional fermented milk products – names and organisms associated (tabulation only)

### III. Bioinstrumentation

[18]

#### A. Centrifuges

1. Preparative centrifuge and its applications (04)
2. Analytical centrifuge and its applications

#### B. Spectroscopic techniques (Principle and applications)

(03)

1. Electron spin resonance (ESR) spectroscopy
2. Nuclear magnetic resonance (NMR) spectroscopy
3. Circular dichroism (CD) spectroscopy



C. Electrophoretic techniques

(05)

1. Principle, types, and instrumentation
2. Applications (especially in protein, nucleic acid) – 1D, 2D, pulse field, sequencing gels, fingerprinting gels
3. Hybrid techniques with Mass Spectroscopy

D. Analytical assay methods – Principles, Working and Applications of Fluorimetry, Spectrophotometry (U.V., Visible, I. R) and Flame photometry, Radioisotopes and autoradiography

(06)

### Text Books

1. Casida L. E., "Industrial Microbiology" (1999), New Age International (P) Ltd, New Delhi
2. Purohit S. S., (2001), "Biotechnology Fundamentals and Applications", 3<sup>rd</sup> Edition, Agrobios, Jodhpur
3. Glick B.R. & Pasternak J. J., (2003), "Molecular Biotechnology, Principles and applications of recombinant DNA", 3<sup>rd</sup> Edition, ASM Press, Washington, USA
4. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2<sup>nd</sup> Edition, Aditya Books Pvt. Ltd, New Delhi.
5. Crueger W. and Crueger A. (2000) "Biotechnology – A Textbook of Industrial Microbiology", 2<sup>nd</sup> Edition, Panima Publishing Corporation, New Delhi.
6. El-Mansi E. M. T. & Bryce C. F. A. (2000), "Fermentation Microbiology and Biotechnology", Taylor and Francis Ltd., New Delhi
7. Jay James M (1996) "Modern Food Microbiology", 4<sup>th</sup> Edition, CBS Publisher
8. Eckel, C. H., Combs, W. B. and Batish, V. K. (1973), "Milk and Milk Products", 4<sup>th</sup> Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi
9. Stanier et al, General Microbiology, Macmillan
10. Web sites of US FDA, AOAC, ISO, US Patent Office etc
11. "Prescott and Dunn's Industrial Microbiology" (1982) 4<sup>th</sup> Edition, McMillan Publishers
12. Prescott and Dunn, Industrial Microbiology
13. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology" Vol1 & 2, Academic Press
14. Bhatia, R (19??), "Quality assurance in microbiology", CBS Publications, New Delhi.

## Practical Syllabus Based On Paper IV

1. Determination of antibacterial spectrum by ditch plate method and preservation of this antibiotic producer by suitable method, Auxanography.
2. Comparison of amylase activity of Aspergillus culture grown in liquid medium and on solid substrate.
3. Chemical and Bioassay of Penicillin
4. Bioautography and Bioassay of Vitamin B12.
5. Production of SCP using yeast, Protein estimation of yeast cells produced (Biuret method)
6. Isolation of lactic acid bacteria from Idli batter
7. Preparation of sauerkraut, and fermented cucumber, Isolation of lactic acid bacteria, titratable acidity, plate count after 2, 7, 14 days and 5 – 6 weeks of fermentation, Breeds count of final product
8. Microbiological analysis of milk, butter, cheese, salted and sweet pickle – DMC, SPC, Coliform Count, YMC, spore bearer in milk powder and detection of osmophiles as per ISI standards, MBRT, RRT, Phosphatase Test.
9. Sugar and alcohol tolerance of Saccharomyces cerevesiae,
10. Ethanol production from jaggery, chemical estimation of alcohol produced, efficiency of fermentation
11. Sterility testing of injectable (DW ampules)

### Demonstrations / Visits / Videos / CD's / Project Reports

Films/Demonstrations/CD ROM's/Visits and Report Writing on the following

1. Report writing: Each student shall write report on any two of the demonstration experiments (Listed in 12)  
Report format is as follows: Introduction, Methods, Results, Discussion and References (Abstracts, Conclusions, Appendices may be included)
2. Visits
  - i. Antibiotic production plant
  - ii. Pharmaceutical Industry
  - iii. Processing and preparation of milk and milk products
  - iv. Vaccine Production Plant (Animal / Human)
  - v. Application of Recombinant DNA in Industrial Production



## Suggested Examination Pattern

Students opting for 6 Units of Microbiology (Major) at T Y B Sc level will study Papers I, II, III, IV of 100 marks each and 4 practicals based on these papers of 50 marks each.

Students opting for 3 Units of Microbiology at T Y B Sc level will study Papers I & II of 100 marks each and 2 practicals based on these papers of 50 marks each.

A student shall submit a brief report on any one of the demonstration based on visits / videos / CD etc. selected from amongst all four practical papers.

Viva / Quiz and spots shall be based exclusively on the practical syllabus **excluding** DEMONSTRATIONS based VISITS / CDs , VIDEOS and REPORT WRITING.

### Theory Examination

4 papers of 100 marks each of 3 hr duration as per the prescribed university pattern for B.Sc. should be followed. Each paper should cover entire syllabus in proportionate manner, using no of lectures assigned to the topic as a rough guideline.

Question paper should contain objective (15 to 20%) as well as subjective questions (80 – 85%). Subjective questions can be on the basis of standard pattern (about 10 -15 such different Q heading / types) followed in the past several years of university examination like essay questions, short notes, how would you, justify, give principles underlying, define with short explanation, structures of compounds, compare/contrast/ differentiate etc. Objective questions can be: define, give examples of / applications / significance / scientists and their contributions etc. Examiners are encouraged to explore newer forms of questions; however the new question pattern should not be more than 15% to 20 % of marks. There should be about 6 questions of 20 marks each with sufficient internal choice and students require solving any 5 questions out of 6.

### Practical Examination

#### 3 Units

As per university directives, should be of 100 marks; 2 practicals of 50 marks each. The following pattern of practical exam is suggested.

Practical 1		Practical 2	
Technique Problem 1	20	Medical	40
Technique Problem 2	10		
Report	5	Rapid diagnostics	10
Viva	5		
Spots /Quiz	5		
Journal	5		
Total	50	Total	50

Techniques and chemical estimation shall be based on all relevant practicals including demonstrations / group experiments based on 2 papers.

Practical examination will be held on 3 consecutive days between 10.00 a.m. to 4.00 p.m. with half hour lunch break.



Laboratory journals and reports are to be duly certified by the Head, Department of Microbiology. Examiners are required to sign the journal and report at the end of examination.

### 6 Units

As per university directives, should be of 200 marks; 4 practicals of 50 marks each. The following pattern of practical exam is suggested.

Practical 1		Practical 2		Practical 3		Practical 4	
Technique [40]		Medical	40	Chemical Estimation	30	Bioassay	40
Problem 1	25	Rapid diagnostics	10				
Problem 2	15			Viva	10	Report	10
Journal [10]				Spots/ Quiz	10		
Total	50	Total	50	Total	50	Total	50

Techniques and chemical estimation will be based on all relevant practical including demonstrations / group experiments based on all 4 paper practicals.

Practical examination will be held on 3 consecutive days between 10.00 a.m. to 5.00 p.m. with half hour lunch break.

Laboratory journals and reports are to be duly certified by the Head, Department of Microbiology. Examiners are required to sign the journal and report at the end of examination.

Both 3 and 6 units students are required to submit at the time of their practical examination, a **handwritten** report of about 10 to 15 pages on recent advances, in last 5 years, in the field related to their syllabus and collected from various sources like latest reference books, reviews, internet and on line journals. HOD, Teacher-in-charge of practical should ensure that the topics given to the class as a whole cover **entire syllabus**. Considering the speed of development in our field, they should also ensure that newer topics for projects are assigned to students every year and **previous years** projects are **not repeated**. List provided at the end of each practical may be used as **guideline**.

