

BHARATHIAR UNIVERSITY, COIMBATORE.
B.Sc., MICROBIOLOGY DEGREE COURSE WITH COMPULSORY
DIPLOMA IN DIAGNOSTIC MICROBIOLOGY
SCHEME OF EXAMINATION - CBCS PATTERN (AFFILIATED COLLEGES)
For the students admitted during the academic year 2008 – 2009 batch onwards

Part	Study Components	Course title	Ins. hrs/ week	Examinations			Credit	
				Dur.Hrs	CIA	Marks		Total Marks
	Semester I							
I	Language – I		6	3	25	75	100	3
II	English – I		6	3	25	75	100	3
III	Core Paper I - Fundamentals of Microbiology		6	3	25	75	100	4
	Practical I and Viva Voce		4	-	-	-	-	-
	Allied A : Paper I – Biostatistics and Computer Applications I		4	3	25	75	100	4
	Allied Practical		2	-	-	-	-	-
IV	Environmental Studies #		2	-	-	50	50	2
	Semester II							
I	Language – II		6	3	25	75	100	3
II	English – II		6	3	25	75	100	3
III	Core Paper II - Microbial Diversity		4	3	25	75	100	4
	Core Paper III - Cell Biology		3	3	25	75	100	4
	Core Practical I and Viva Voce		3	3	40	60	100	3
	Allied A : Paper II - Biostatistics and Computer Applications II		4	3	25	75	100	4
	Allied Practical		2	3	20	30	50	2
IV	Value Education – Human Rights #		2	3	-	50	50	2
	Semester III							
I	Language – III		6	3	25	75	100	3
II	English – III		6	3	25	75	100	3
III	Core Paper IV - Microbial Physiology		4	3	25	75	100	4
	Core Practical II		3	3	-	-	-	-
	Allied B: Paper I – Biochemistry I		4	3	20	55	75	4
	Allied Practical		2	-	-	-	-	-
IV	Skill based Subject I Diploma in Diagnostic Microbiology – Organization of Clinical Microbiology Laboratory		3	3	25	75	100	3
	Tamil @ / Advanced Tamil# (OR) Non-major elective - I (Yoga for Human Excellence)# / Women’s Rights#		2	3	75		75	2
	Semester IV							
I	Language – IV		6	3	25	75	100	3
II	English – IV		6	3	25	75	100	3
III	Core Paper V – Bioinstrumentation – Principles and Applications		4	3	25	75	100	4
	Core Practical – II		3	6	40	60	100	3

	Allied B : Paper II – Biochemistry II	4	3	20	55	75	4
	Allied Practical	2	3	20	30	50	2
IV	Skill based Subject 2 - Diploma in Diagnostic Microbiology – Diagnostic Microbiology I (Bacteriology and Serology)	3	3	25	75	100	3
	Tamil @ /Advanced Tamil # (OR) Non-major elective -II (General Awareness #)	2	3	75		75	2
	Semester V						
III	Core Paper VI - Microbial Genetics	5	3	25	75	100	4
	Core Paper VII – Principles of Immunology	4	3	25	75	100	4
	Core Paper VIII– Food Microbiology	4	3	25	75	100	4
	Core Paper IX – Recombinant DNA Technology - I	4	3	25	75	100	4
	Elective 1	4	3	25	75	100	5
	Core Practical - III	6	3	-	-	-	-
IV	Skill based Subject 3 Diploma in Diagnostic Microbiology – Diagnostic Microbiology II (Virology and Mycology, Parasitology)	3	3	25	75	100	3
	Semester VI						
III	Core Paper X – Fermentation Technology	4	3	25	75	100	4
	Core Paper XI – Environmental and Agricultural Microbiology	4	3	25	75	100	4
	Core Paper XII – Virology	4	3	25	75	100	4
	Core Practical – III	6	9	40	60	100	4
		-	-	-	-	50 *	2
	Elective – II	4	3	25	75	100	5
	Elective – III	4	3	25	75	100	5
IV	Skill Based Subject 4 Diploma in Diagnostic Microbiology – Practical I & II	4	3	40	60	100	3
V	Extension Activities @	-	-	-	-	50	1
	Total					3800	140

* - Students has to submit a record of work done during their training period which will be evaluated through *viva voce* along with the core practical III examination.

Students should undergo an institutional training for a continuous period of 15 days before semester VI

@ No University Examinations. Only Continuous Internal Assessment (CIA)

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List of Elective papers (Colleges can choose any one of the paper as electives)		
Elective – I	A	Recombinant Dna Technology - II
	B	Dairy Microbiology
	C	Biomolecules
Elective – II	A	Medical Microbiology - I
	B	Medical Biochemistry
	C	Plant Biotechnology
Elective - III	A	Medical Microbiology – II
	B	Enterpreneurial Microbiology
	C	Bionanotechnology

SEMESTER - I

CORE PAPER I : FUNDAMENTALS OF MICROBIOLOGY

UNIT – I

History and Scope of Microbiology – Spontaneous generation theory – conflict – Contribution of Leuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Joseph Lister, Winogradsky, Waksman, John Tyndall.

UNIT – II

Microscopy and Staining -Microscopy – Principles and application – Bright field, Dark field, Phase contrast, Fluorescence, SEM & TEMS- Specimen preparation of electron microscopy – freeze etching- Staining- Stains and Staining reactions – Types of staining – Simple, Differential (Gram's, Spore, AFB₁), Capsule staining, Nuclear and Flagella staining-Albert.

UNIT – III

Sterilization and Disinfection- Principles- Methods of Sterilization – Physical methods – Dry heat- Moist heat, Filtration (Membrane & HEPA) - Radiation – Chemical Sterilization -Chemical agents Mode of action – Phenol coefficient test- Sterility testing.

UNIT – IV

Culture techniques -Media preparation -Solid and Liquid- Types of Media – Crude, Semi Synthetic, Synthetic, Enriched, Enrichment, Selective, Differential and Special Purpose Media (one eg for each type). Anaerobic culture technique-- Wright's tube, Roll tube, McIntost fildes jar method -Pure culture technique – Tube dilution, Pour, Spread, Streak and Micromanipulator.

UNIT – V

Estimation of Microbes- Direct Microscopic count, Turbidometric assay, TVC- Indirect Method- CO₂ liberation -Protein estimation- Maintenance and Preservation -Short term – Slant, Stab, Mineral oil overlay -Long term – Lyophilization, Cryo preservation, Storage in sterile soil, Storage in silica gel.

References

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2. Salle A.J. : Fundamental Principles of Bacteriology 7th edition, Tata Mc Hill Publishing Company Ltd.,
3. Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
4. Stainer R.Y. Ingraham J.L. Wheolis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentica Hall..
5. William claus. G.W. 1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
6. Wilson. K and Goulding. K.H. 1986. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, ELBS, London.

7. Tauro P., Kapoor, K.K. Yadav, K.S. An introduction to Microbiology first Edition, New Age International Publishers.

SEMESTER -II
CORE PAPER II : MICROBIAL DIVERSITY

UNIT – I

Taxonomy – Principles – Modern approaches-Numerical- Genetic, Serotaxonomy and Chemotaxonomy.

UNIT – II

Taxonomy of Eubacteria and Actinomycetes – Detailed classification upto genus level with general characters of each group – Bergey's Manual and its importance.

UNIT – III

Taxonomy of Photosynthetic Eubacteria and Archaeobacteria- General characteristics.

UNIT – IV

Taxonomy of Fungi (Alexopolous) -General Characteristics-Life Cycles of Mucor, Neurospora, Agaricus, Dictyostelium.

UNIT – V

Taxonomy of Algae -General Characters and its importance –Chlorophyta-Euglenophyta – Chrysophyta- Phaeophyta -Rhodophyta – Pyrrophyta-Taxonomy of Protozoa – General characters and its importance – Mastigophora, Rhizopoda, Ciliata, Sporozoa.

References

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2. Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
3. Stainer R.Y. Ingraham J.L. Wheelis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentice Hall.

SEMESTER -II
CORE PAPER III :CELL BIOLOGY

UNIT – I

Ultrastructure of Eubacteria-Cell wall – Cell membrane- Extra mural layer - Slime – Capsule – Cytoplasmic inclusions – Mesosomes – Nuclear material – Reserve materials - Pigment – Cell appendages – Flagella – Pili.

UNIT – II

Ultrastructure and functions of Eukaryotic cell organelles – Cell wall – Cell membrane - Mitochondria – Chloroplast – Endoplasmic reticulum – Golgiconplex – Nucleus – Ribosomes – Other cell inclusions and Flagella.

UNIT III

Cell division in Bacteria – Binary fission - Cell division of Eukaryotes – Mitosis and Meiosis.

UNIT IV

Transport mechanisms – Diffusion - Facilitated diffusion – Active transport – Group translocation – Phagocytosis – Pinocytosis.

UNIT V

Archaeobacterial cell wall and cell membranes of Methanogens - Halophiles - Thermoacidophiles.

References

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2. Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
3. Stainer R.Y. Ingraham J.L. Wheelis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentice Hall.

SEMESTER II GR A CORE PRACTICAL 1

1. Laboratory precautions
2. Preparation of cleaning solutions
3. Antiseptics and disinfectants
4. Principles of aseptic techniques
5. Culture media preparation – Liquid and Solid medium
6. Selective and differential media
7. Methods of sterilization and testing of sterility
8. Enumeration of Bacteria, Fungi and Actinomycetes from soil
9. Pure culture techniques – pour plate, spread plate and looping method
10. Phenol co-efficient test
11. Cultural characteristics of microorganisms-colony morphology on nutrient agar slants, nutrients broth
12. Maintenance and preservation of cultures
13. Staining of bacteria-Simple, Negative, Gram, Spore and AFB, Fungal wet mount –LCB-Slide culture method
14. Isolation of halophiles and thermophiles
15. Cultivation of anaerobic micro organisms – Wrights tube – McIntosh fildes jar
16. Micrometry
17. Observation of representative forms of (algae) –Diatoms-Chlamydomonas-Volvox-Cyanobacteria-Oscillatoria-Nostoc-Anabaena-(Fungi)-Aspergillus-Penicillium-Rhizopus-Yeast-(Protozoa)-Amoeba-Plasmodium.

References

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2. Salle A.J. : Fundamental Principles of Bacteriology 7th edition, Tata Mc Hill Publishing Company Ltd.,
3. Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
4. Stainer R.Y. Ingraham J.L. Wheelis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentica Hall..
5. William claus. G.W. 1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
6. Wilson. K and Goulding. K.H. 1986. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, ELBS, London.
7. Tauro P., Kapoor, K.K. Yadav, K.S. An introduction to Microbiology first Edition ,New Age International Publishers.

SEMESTER –III CORE PAPER IV : MICROBIAL PHYSIOLOGY

UNIT – I

Nutrition: Nutritional requirements of microorganisms – Autotrophs, Heterotrophs, Photoautotrophs, Chemoautotrophs, Copiotrophs, Oligotrophs, Endospore formation in Bacteria.

UNIT – II

Different phases of growth – growth curve – generation time – factors influencing microbial growth – temperature, pH, pressure , salt concentration , nutrients – synchronous growth and continuous cultivation . Diauxic growth.

UNIT -III

Metabolism – EMP – HMP – ED pathways – TCA cycle- Electron transport chain – Oxidative and Substrate level phosphorylation.

UNIT- IV

Anaerobic respiration – sulphur , nitrogenous compounds and Co₂ as final electron acceptor- Fermentation – alcoholic, propionic and mixed acid fermentation.

UNIT- V

Photosynthesis – Oxygenic and Anoxygenic , Carbon dioxide fixation, Biosynthesis of bacterial cellwall, biosynthesis of aminoacids (glutamic acid family)- Bioluminescence.

References

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2. Tortora , Funke and case . Microbiology , *8th edition
3. Doelle . H.W.1975.Bacterial Metabolism . 2nd edition .Academic Press.
4. Moat. A.G. J.W.Foster. 1988.Microbial physiology. 2nd edition .Springer – Verlag.
5. Caldwell. D.R.1995, Microbial physiology and Metabolism . Wm. C Brown Publishers, England.

SEMESTER –IV CORE PAPER V: BIOINSTRUMENTATION PRINCIPLES AND APPLICATIONS

UNIT – I

Autoclave , Hot air oven , Incubator , Water Bath , Laminar air flow, BOD incubator, Centrifuges – Bench top , High sped , Ultra centrifuge.

UNIT – II

pH meter , Conductivity meter, Lyophilizer , McIntosh anaerobic jar , Biosensor, Metabolic shaker.

UNIT -III

Chromatography – Paper , Thinlayer, Column, Ion-exchange, Gas and HPLC – Electrophoresis – SDS – PAGE and Agarose gel electrophoresis.

UNIT –IV

Colorimetry, Turbidometry, Spectrometry – UV & Visible spectrophotometer . Flame photometry- Micronutrient analysis.

UNIT-V

Biochemical calculations-preparations of Molar solutions - Buffers- Phosphate, Acetate, TE, TAE- calculation of Normality ,PPM- Ammonium sulphate precipitation.

References

1. Gedder , A. and L. E. Balser, John Wiley and Sons , Principles of applied Biomedical instrumentation.
2. Dean, Willard and Merrit , Instrumental Methods of analysis Asian Ed.
3. Fritschen, L. J and L. W . Gay, Springer, Verlag, Environmental Instrumentation, 1979, New York.
4. Boyer, Rodney, F. Benjamin and Cummins, Modern Experimental Biochemistry 2nd Edition.
5. E.Padmini., Biochemical Calculations and Biostatistics (2007) Books and Allied(P) Ltd., First Edtn.

SEMESTER IV GR A CORE PRACTICAL II

1. pH measurements
2. Spectrophotometry
3. Protein estimation (Lowry *et al* / Bradford)
4. Paper chromatography
5. Thin layer chromatography
6. Electrophoresis - Proteins
7. Measurement of microbial growth – viable count – direct count – turbidity methods – determination of generation time
8. Extraction of pigments
9. Physiological characterization : Indole, MR, VP, Citrate utilization tests, Carbohydrate fermentation tests – TSI – H₂S production – Starch hydrolysis – Catalase – Oxidase – Urease – Nitrate – Gelatin and Casein hydrolysis tests
10. Preparation of Buffers – Acidic and Alkaline range
11. Preparation of Molar solutions
12. Preparation of 0.1 and 1 Normal solutions

SEMESTER -V CORE PAPER VI - MICROBIAL GENETICS

UNIT-I

DNA-the genetic material, RNA-the genetic material, characters of a genetic material, chemistry & molecular structure of DNA, special structure of DNA, structure and types of RNA.

UNIT-II

Bacterial chromosome, organization of genes in prokaryotes, DNA_– replication in prokaryotes – Meselson and Stahl experiment- mechanism & enzymology of replication – theta replication & rolling circle replication.

UNIT-III

Transcription in prokaryotes – genetic code – translation of proteins – regulation of gene expression in prokaryotes – Operon concept – lac & trp Operon.

UNIT-IV

Mutation-spontaneous and induced-mutagen & mutagenesis – DNA repair mechanism.

UNIT-V

Genetic exchange – transduction(specialized & generalized), transformation, conjugation & Hfr mapping , genetic recombination.

References

1. Gardner, E. J., Simmons, M J & D P Snustard, 1991, Principles of Genetics, 8th edition. John Wiley & Sons. NY.
2. Freifelder .S, 1987 Microbial Genetics, Jones & Bartlett, Boston.
3. Robert H .Tamarin. Principles of Genetics, 5th edition, Cm Brown Publishers.
4. Lewin.B, 1990. Genes, 6th edition, Oxford University Press.
5. Klug .W.S. & Cummings, MR, 1996, Essentials of Genetics, Mentics Hail. New Jersey.

SEMESTER -V **CORE PAPER VII - PRINCIPLES OF IMMUNOLOGY**

UNIT- I

History and Scope of Immunology-The basis of defence mechanisms-Cell and Organs involved in immune system-Phagocytosis.

UNIT- II

Types of immunity-antigen-antibody-types-complement pathways-classical and alternate-Immunoglobins-structure and functions.

UNIT- III

Allergy and hypersensitivity-classification types and mechanisms-autoimmunity-mechanisms and autoimmune response diseases.

UNIT -IV

Quantitative study of antigen-antibody reactions –agglutination, precipitation ELISA-radioimmune assay(RIA)-monoclonal antibodies and its applications(Hybridoma technology)

UNIT –V

Immunohematology-blood transfusion-ABO grouping-Rh factor-Tissue transplantation-HLA typing-mechanism of acceptance and rejection.

References

1. Kuby.J.1997 . ,Immunology, W.H.Freeman, NY
2. Tizard, I R 1998. Immunology An Introduction , Second edition. W.B.Saunders, Philadelphia.
3. Roitt, IM 1991. Essentials of Immunology, seventh edition Blackwell Scientific Publications.
4. Nandhini Shetti, 1993. Immunology, Introductory Text Book. New Age International Limited.

SEMESTER –V

CORE PAPER VIII - FOOD MICROBIOLOGY

UNIT – I

Food and microorganisms – Important microorganisms in food (Bacteria, mold and yeasts) ; factors affecting the growth of microorganisms in food – pH, moisture , oxidation – reduction potential , nutrient content and inhibitory substances and biological structure.

UNIT – II

Principles of food preservation – general principles and application methods – Asepsis - Techniques of removal – use of temperature (low & high). Drying, radiation and chemical preservatives.

UNIT -III

Spoilage of food - cereals , vegetables , fruits , egg and milk – canned foods .

UNIT-IV

Fermented food – pickled cucumber , saurkraut- soysauce , Bread , Idli – Fermented dairy products – Yoghurt and cheese.

UNIT- V

Food borne diseases – food poisoning and food borne infections – bacterial and mycotoxins- Investigation of food poisoning outbreaks- food standards, quality control.

References

1. Frazier. W.C and D.C Westhoff . 1978. Food Microbiology . 3rd ed. Tata Macgraw Hill Publishing Co., New Delhi.
2. Jay,J.M .1991 . Modern Food Microbiology 4th edition , Van Nostra and Rainhokdd Co.
3. Adams. M. R and M. D Moss . 1995. Food Microbiology . New Age International limited

SEMESTER –V

CORE PAPER IX

RECOMBINANT DNA TECHNOLOGY- I

UNIT- I

Gene manipulation – Definition and Application, Restriction Enzymes, Discovery, Types and Mode of Action, Ligases and Methylases.

UNIT -II

Isolation - Purification of DNA (Chromosomal and Plasmid), Isolation and Purification of RNA, Chemical Synthesis of DNA, Genomic Library and cDNA Library.

UNIT -III

Vectors – Plasmid based Vectors- Natural (PSC101, PSF2124, PMB1), Artificial – pBR322 & pUC Construction: Phage based Vectors- λ (Lamda) phage Vectors and its Derivatives: Hybrid Vectors- Phagemid, Phasmid and Cosmid, BAC and YAC.

UNIT -IV

Gene Transfer Techniques: Physical – Biolistic Method , Chemical- Calcium chloride and DEAE Methods , Biological invitro package method - Screening and Selection of recombinants- Direct Method – Selection by Complementation, Marker inactivation Methods , -Indirect Methods- Immunological and Genetic Methods

UNIT- V

PCR , Blotting (Southern, Western, Northern) Techniques, RFLP and Application , - RAPD and Application,-Microarray.

References

1. Old. RW and Primrose, 1995 Principle of Gene Manipulation, 5th edition. Blackwell Scientific Publication ,Boston.
2. Winnecker, E.D, 1987- From gene to clones, Introduction to Gene Technology, VCH Publication, FRG.
3. T.A Brown 1995, 3rd edition , An introduction to Gene Cloning ,Chapman and Hall .
4. Glick B .R and Pasternak J .J ,1994 .Molecular Biotechnology. Principles and Application of recombinant DNA, ASM Press ,Washington.

SEMESTER -VI **CORE PAPER X - FERMENTATION TECHNOLOGY**

UNIT -I

Industrially important strains- Screening methods- Strain development for Improved yield- Mutation, Recombination and protoplasmic fusion.

UNIT -II

Fermentation- submerged and solid state- component parts of a CSTR- types of Fermentors (Tower, cylindroconical & airlift) – batch fermentation – continuous Fermentation.

UNIT -III

Production of beverages – beer and wine- vitamin B12 and Riboflavin – Antibiotics- penicillin and streptomycin- production of enzymes- Amylases and Proteases- methods of immobilization.

UNIT- IV

Single cell protein- Bakers yeast, spirulina- Details of mushroom development- Oyster (Pleurotus) and Button (Agaricus) mushroom.

UNIT -V

Downstream process- Intercellular and extracellular- Centrifugation, filtration, Flootation- solvent extraction, precipitation- Breakage of cells- physical and Chemical methods.

References

1. Stanbury P T and Whitaker 1984, Principles of Fermentation Technology, Pergamon Press. NY
2. Casida, L E JR 1968 Industrial Microbiology. New Age International Publishers.
3. Prescott and Rehm 1979. Industrial Microbiology. Wiley and Sons.

SEMESTER -VI CORE PAPER XI

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

UNIT -I

Distribution of microorganisms in nature – Microbial communities in soil- factors Influencing the microbial density in soil- zymogenous and autochthonous flora in Soil- Microbial associations – symbiotic proto cooperation, ammensalism, Commensalism, syntropism, parasitism and predation with suitable examples.

UNIT -II

Microbial decomposition; cellulose, Hemi cellulose, lignin, pectin and chitin. –Factors influencing degradation- acetate utilization -bioconversion of organicwastes- sugarcane wastes- coir pith composition- composting, principles and Applications- conversion process

UNIT- III

Microorganisms in the decomposition of organic matter- carbon cycle – nitrogen Cycle- nitrogen fixing microorganisms- root nodule bacteria – non symbiotic Nitrogen fixers – biofertilizers in agriculture- Rhizobium and phosphate solubilisers- Mycorrhizial association – phosphorous cycle.

UNIT- IV

Water microbiology, algae, phytoplankton- eutrophication- water treatment- Primary, secondary and tertiary. Drinking water- Portability- MPN technique.

UNIT-V

Aero microbiology- aerosol, droplet nuclei, air pollution- sources (Microbiological) – air quality analysis- air sampling devices.

References

1. Atlas R. M. and Bartha. R 1992, Microbial Ecology . Fundamental and application . 3rd edition Benjamin and Cummings.
2. Alexander A M 1987. Introduction to Soil Microbiology, 5th edition John Wiley and sons,
3. Alexander, A M 1974. Microbiology Ecology, Jhon Willy & Sons.
4. Mitchell R 1974, Introduction to Environmental Microbiology, Prentice Gall Inc., Englewood Cliffs.
5. Rangasamy, G and D J Bagyaraj, Agricultural microbiology, Asia Publishing House, New Delhi.
6. Rheinhermer , G. 1986 . Aquatic Microbiology , John Wiley and Sons , NY.
7. Grant. W. D. P . E. Long . 1981 Environmental Microbiology, Thomson Litho Ltd.

SEMESTER -VI CORE PAPER XII - VIROLOGY

UNIT -I

Early development of virology – general properties of viruses- cultivation of Viruses- virus purification and assays. The structure of viruses- virion size- General structure properties- helical capsids, icosohedral capsid- nucleic acids- Viral envelopes and enzymes- virus classification.

UNIT- II

Reproduction of DNA phages- ds DNA lytic phages- lytic cycle of T4 phage The one step growth- adsorption to the host cell and penetration- synthesis of Phage nucleic acids and protein assembly of phage particles- release of phage particles. Example of ss DNA phage- OX 174- circle replication.

UNIT-III

Lysogeny- temperate bacteriophages- lambda phage- induction of lysogens- Generation of defective phages and their uses. Reproduction of RNA phages.

UNIT -IV

Viruses of Eukaryotes- Reproduction of animal and plant viruses- Viruses of Algae, fungi and viruses- viruses and cancer.

UNIT- V

Human viral infections- pathogenicity and diagnosis of Hepatitis (A,B).
Mumps, AIDS, Rabies, Influenza, Measles, Rubella, Herpes simplex I&II..

References

1. Luria S.E. Darnel, J.E Jr. Baltimore. D and Campbell A. 1978. General Virology 3rd edition, Wiley and sons.
2. Prescott L.M, Harley, J.P Klein D.A. 1900. Microbiology Wm C Publishers.

SEMESTER VI CORE PRACTICAL III

1. Isolation of Nucleic acids
2. Isolation of drug resistant mutants using UV and Chemical agents
3. Induction of Lac Operon – ONPG method
4. Isolation of *E. coli* plasmid DNA by agarose gel electrophoresis
5. Isolation and identification of major bacterial pathogens – *E. coli*, *Klebsiella pneumoniae*, *Proteus*, *Salmonella*, *Shigella*, *Pseudomonas*, *Staphylococcus aureus* and *Streptococcus pyogenes*.
6. Identification of clinically important fungi – *Candida albicans*, *Cryptococcus neoformans* and *Aspergillus*
7. Methylene blue reduction test
8. Microbial analysis of spoiled food –Bread and Vegetables
9. Identification of fungal food spoilers –*Aspergillus*, *Mucor*, *Penicillium*, *Rhizopus*
10. Direct microscopic examination of curd – observation of lactobacilli
11. Enzyme production and assay – protease and amylase
12. Alcohol production / wine
13. Immobilization- Demonstration
14. Isolation of free living nitrogen fixers –*Azotobacter*, *Azospirillum* – Phosphate solubilizers – *Rhizobium* from nodule
15. Observation of parasites – *Entamoeba*, *Plasmodium*, *Ascaris*, *Taenia*.
16. Isolation and titration of coliphages
17. Cultivation of animal viruses in embryonated eggs.

SEMESTER III
DIPLOMA IN DIAGNOSTIC MICROBIOLOGY

DIPLOMA PAPER I

ORGANIZATION OF CLINICAL MICROBIOLOGY LABORATORY

UNIT –I

Diagnostic microbiology – Purpose and philosophy. Purpose of diagnostic microbiology – responsibility - specimen collection & transport – rejection of specimen – expediting results.

UNIT – II

Laboratory safety. General safety considerations – biohazards and practices specific to microbiology – classification of biological agents on the basis of hazards.

UNIT – III

Special precautions for specific areas of clinical Microbiology – Bacteriology, Mycobacteriology, Mycology, Parasitology, Virology and Serology.

UNIT –IV

Laboratory organization and quality assurance – specimen procurement and identification – laboratory requisition form – reporting results – procedure manual – Quality assurance and statistics.

UNIT – V

Management of clinical Microbiology laboratory – general approaches– rapid detection – speeding up of identification results and susceptibility results – computerization.

References

1. Diagnostic Microbiology, Bailey & Scott, s, 1990 8th edn. The Mosby Company.
2. Medical laboratory manual for tropical countries, Microbiology by Monica chees brough (ELBS) Tropical health technology butter worth's, 1985.
3. Review of medical microbiology, Jawetz, E.Melinic, J.C., and Adelbuerg, E.A., 1998, Large medical publications USA.
4. Manual of clinical Microbiology Lenetle, E., Balows, H.A., Hausler, W.J. and Shadomy, J., 1985. Bethesda American society of Microbiology.

SEMESTER IV
DIPLOMA PAPER II
DIAGNOSTIC MICROBIOLOGY – I
(BACTERIOLOGY AND SEROLOGY)

UNIT – I

Selection, collection and transport of specimens – Blood, Urine, Sputum, CSF, Pus & Faeces – transport media and storage. Microscopic examination of specimen for Bacterial pathogens – simple, differential staining and motility.

UNIT – II

Cultivation and isolation of viable pathogens – Media used – differential, selective, enrichment and enriched media.

UNIT – II

Cultivation and isolation of viable pathogens – Media used – differential, selective, enrichment and enriched media.

UNIT – III

Biochemical tests – identification of organisms - Susceptibility testing, reporting of results and interpretation.

UNIT – IV

Serology – Antigen - antibody reactions – Agglutinations (blood grouping, WIDAL), Precipitation (VDRL), Immunodiffusion – mono and double immunodiffusion, Immunolectrophoresis (rocket, counter current).

UNIT – V

Advanced techniques – automated methods – ELISA, RIA. Applications of Nucleic acid hybridization, PCR and blotting in diagnosis.

References

1. Diagnostic Microbiology, Bailey and Scott's., 1990. Eighth edition. The C.V. Mosby Company.
2. Medical laboratory techniques, Abdul Khader, 2003, First edition. Frontline Publications, Hyderabad.
3. Medical laboratory manual for tropical countries. Microbiology by Monica chees brough (ELBS). Tropical Health Technology, Butter worths, 1985.
4. Manual of Clinical Microbiology, Lenetle, E., Balows, H.A., Hausler, W.J and Shadomy J., 1985. Bethesda American Society of Microbiology.

SEMESTER V

DIPLOMA PAPER III DIAGNOSTIC MICROBIOLOGY –II (VIROLOGY, MYCOLOGY AND PARASITOLOGY)

UNIT –I

Laboratory methods in basic Mycology –Collection and transport of clinical specimens –Direct Microscopic examination, culture media and incubation, Serological tests for fungi – Antifungal susceptibility testing

UNIT –II

Laboratory methods for parasitic infections – Diagnostic techniques for faecal, gastrointestinal and urino-genital specimen.

UNIT –III

Identification of Intestinal Protozoa –Amoeba, Blood protozoa – Malaria, Intestinal Helminthes and Blood Helminthes.

UNIT –IV

Laboratory methods in basic virology- detection of viral antigen (fluorescent antibody and solid phase immunoassays). Viral Serology- Special consideration- Hepatitis and AIDS.

UNIT –V

Viral culture- Media and cells used –Specimen processing – isolation and identification of viruses.

References

1. Diagnostic Microbiology, Bailey and Scott's., 1990. Eighth edition. The Mosby Company.
2. Medical laboratory techniques, Abdul Khader, 2003, First edition. Frontline Publications, Hyderabad.
3. Virology, Sawant, K.C., 2005, First edition, Dominant Publishers and distributors, Delhi.
4. Medical Parasitology, Rajesh Karyarkarte, Ajit Damla, 2004. Books and allied publishers Ltd. Kolkata.
5. Textbook of Medical Parasitology, Subash O. Barija , 1996. First edition. All India Publishers and Distributors Regd. 920 Poonamallee High Road, Chennai.
6. Rajesh Karyakarte and Ajith Damle (2005)Medical Parasitology, ooks and Allied(P)Ltd.

**SEMESTER VI
DIPLOMA PAPER IV**

DIPLOMA PRACTICAL –I

1. Collection and transport of clinical specimens –Urine, Blood, Sputum, Pus and Faeces.
2. Processing of specimen
 - 2.1- Gram's Staining
 - 2.2- Motility
 - 2.3-Culturing techniques-McConkey agar, Blood agar, Chocolate agar, Mannitol salt agar and XLD agar
3. Biochemical Characterization- IMViC, TSI, GLSM, Oxidase, Catalase, Urease and Coagulase.
4. Susceptibility testing- Kirby Bauer method.

DIPLOMA PRACTICAL –II

1. Slide agglutination -Blood grouping
2. Tube agglutination- WIDAL
3. Precipitation – RPR
4. Immunodiffusion- Radial, Ouchterlony's
5. Immunoelectrophoresis- Rocket and Counter current
6. ELISA
7. SDS-PAGE
8. Western blot
9. Observation of fungi- LCB or KOH mount
10. Observation of parasites- *Entamoeba*, *Plasmodium*, *Ascaris*, *Taenia*

ELECTIVE I – A

RECOMBINANT DNA TECHNOLOGY- II

UNIT –I

Microbial synthesis of commercial products-Proteins-Pharmaceuticals – Interferons - Human growth hormone- Antibiotics -Biopolymers.

UNIT –II

Vaccines – subunit vaccines –Monoclonal antibody. Gene therapy, Regulating the use of Biotechnology

UNIT –III

Transgenic plants-Ti plasmid – insect, virus, herbicide resistant plants – microbial insecticides – bacteria, fungi and viruses.

UNIT IV

Transgenic animals – mice – retroviral method – DNA Microinjection method – embryonic stem cell method- Application-Transgenic pig- cattle- sheep Goat – transgenic fish and birds.

UNIT -V

DNA finger printing and its Application.

Human Genome Project and History and its Application , Bioremediation.

References

1. Brown T.A 1995 An Introduction to gene cloning.3rd edition. Chapman and hall
2. Bernard. R Glick and Jack J Pasternak. 1994 Molecular biotechnology, Panima Publishing Corporation.
3. U.Sathyanarayana., Biotechnology Books and Allied(P) Ltd.,(2005)First Edition.

ELECTIVE I – B : DAIRY MICROBIOLOGY

Unit I

Milk-Introduction, composition,. Microorganisms in Milk – Bacteria, Yeasts, Moulds. Starter Cultures – Starter cultures their biochemical activities. (Streptococcus thermophilus, Lactobacillus bulgaricus) starter culture preparation, mesophilic and thermophilic organisms. Dairy processing unit operations: Clarification, separation, standardization, toning of milk, Pasteurization, UHT treatment, homogenization, Membrane processing, storage, transportation and distribution of milk. Judging and grading of milk and its products.

Unit II

Milk and milk products – Definitions, composition, food and nutritive value of milk, properties of milk and its constituents. Dairy Products Production : Overview

and Fluid Milk Products, Concentrated and Dried Milk Products, condensed milk, evaporated milk, whole and skimmed milk powder, cultured Dairy Products: Cheese, yogurt, fermented beverages, Whipped Cream, Ice Cream, Butter, Whey Products, fermented milks,

Unit-III

Microbiology of fermented milk products - Acid fermented milks (acidophilus milk, yoghurt). Slightly acid fermented milks (Cultured butter milk), Acid-alcoholic fermented milk (Kefir). Fermented milk production with extended self life (labneh). Milk borne diseases, antimicrobial systems in milk, sources for contamination of milk - bacterial with examples of infective and toxic types -, Clostridium, Salmonella, Shigella, Staphylococcus, Campylobacter, Listeria. Mycotoxins in food with reference to Aspergillus species.

Unit – IV

Hygiene in Manufacturing Milk Products: Microorganisms of concern – HACCP - Pasteurization - Cleaning of Dairy Equipment - Instantization of milk and milk products. In-plant cleaning system. Dairy Processing Plant Sanitation . Probiotic role of lactic acid bacteria and fermented milk products. Utilization and disposal of dairy by product – whey.

Unit V

Quality assurance: Microbiological quality standards of food. Government regulatory practices and policies. FDA, EPA, HACCP, ISI. HACCP – Food safety, safety of dairy products, control of hazards

References

1. Fundamentals of Dairy Microbiology by Prajapati.
2. Dairy Microbiology by Robinson R.K.1990 Volume II and I. Elsevier Applied Science, London.
3. Applied dairy microbiology edited by Elmer Marth and James Steele.
4. Milk & Milk Products - Fourth edition - clarence henry eckles, Tata McGraw Hill publishing company Limited, New Delhi, 1957
5. Dey, S. 1994. Outlines of Dairy Technology. Oxford Univ. Press, New Delhi. MaCrae
6. Robinson, R.K. (2 vol. set). 1986. Modern Dairy Technology Elsevier Applied Science, UK.
7. Rosenthal, I. 1991. Milk and Milk Products. VCH, New York.
8. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi.
9. Yarpar, WJ. and Hall, C.W. 1975. Dairy Technology and Engineering AVI, Westport.

ELECTIVE I – C : BIO-MOLECULES

UNIT - I

Carbohydrates: Definition, classification, stereochemistry, cyclic structures and anomeric forms, Haworth projections. Monosaccharides-Reactions-Characteristics of aldehyde and ketone groups. Action of acids and alkalies on sugars. Reactions of sugars due to

hydroxyl groups. Disaccharides- Structure, chemistry and function – Sucrose, Lactose, Maltose and Cellobiose. Trisaccharides-Structure of Raffinose. Polysaccharides. [Structures not required]. Homopolysaccharides-starch, glycogen, cellulose, chitin, dextrin and inulin. Heteropolysaccharides-hyaluronic acid, chondroitin sulfate and heparin. Artificial sweeteners – Saccharin Aspartame, Monellin, Neohesperidine dihydrochalcone.

UNIT - II

Lipids; Definition, classification of lipids, simple compound and derived. Simple lipids-Physical and chemical properties of fats. Characterisation of fat – Saponification number, acid number, Iodine number and RM number. Compound lipids-Structure and function of phospholipids, glycolipids and lipoproteins. Derived lipids-Fatty acids-saturated and unsaturated. Essential fatty acids. Steroids-Structure of cholesterol, ergosterol and stigma sterol. Value of lipids in cardiovascular diseases (Atherosclerosis).

UNIT- III

Amino acids and peptides. Definition, amino acids as ampholytes. Structure and classification of amino acids based on chemical nature, chemical reaction of amino acids due to carbonyl and amino groups. Essential amino acids Peptides; Structure and properties. Identification of N and C terminal residues. Determination of primary structure of peptides-Glutathione, Oxytocin and Vasopressin.

UNIT- IV

Nucleic acids; Structure of Purines and Pyrimidines; Nucleotides and Nucleosides. DNA: double helix: A, B and Z forms; DNA denaturation and renaturation. RNA: types, unusual bases. DNA as genetic material Structure of chromatids, nucleosome and histones.

UNIT- V

Vitamins and Minerals Vitamins: Definition, Classification. Fat soluble vitamins-sources, structure and physiological functions; Water soluble vitamins-sources, structure and physiological functions. Minerals: Mineral requirement, essential macro minerals and essential micro minerals, sources and functions.

REFERENCES

1. Ambika Shanmugam, Fundamentals of Biochemistry for Medical Students.
2. Deb, A.C., Fundamentals of Biochemistry, New Central Agency, Calcutta, 3rd Edition, 1989.
3. Lehninger, A.L., Nelson, D.L., Cox, M.M., Principles of Biochemistry, CBS Publishers, 2nd Edition, 1993.
4. Lubert stryer, Biochemistry, Freeman and company, 4th Edition, 1995.
5. Rastogi S.C, V.N. Sharma, Anuradha Tanden, Concepts in molecular biology, 1993.
6. Jain J.L, Fundamentals of biochemistry, S.Chand Publication 6th Edition, 2005.

ELECTIVE II - A MEDICAL MICROBIOLOGY - I

UNIT- I

Infections- sources of infections- types of infections- methods of infections- definitions- epidemic, pandemic, endemic diseases- Epidemiology of infectious diseases, infectious diseases cycle- investigation of epidemics- control of epidemics.

UNIT- II

Morphology, pathogenicity and laboratory diagnosis- Gram positive organisms *Staphylococcus aureus*, *Streptococcus pyogenes*, *Bacillus anthracis*, *Corynebacterium diphtheriae*.

UNIT- III

Morphology, pathogenicity and laboratory diagnosis- Gram positive Organisms- *Clostridium perfringens*, *Clostridium tetani*.

UNIT- IV

Morphology, pathogenicity and laboratory diagnosis- Gram negative organisms *Escherichia coli*, *Klebsiella*, *Proteus*, *Salmonella*, *Shigella*, *Pseudomonas*, *Vibrio cholerae*.

UNIT -V

Morphology, pathogenicity and laboratory diagnosis- *Mycobacterium Tuberculosis*, *Mycobacterium leprae*, *Treponema pallidum*, *Leptospira*, *Chlamydiae*, *Rickettsiae*.

References

1. Mackie and Mc catney, 1994, Medical Microbiology No I and II. Churchill Livingstone, 14th edition.
2. Ananthanarayanan R and CK Jayaram Panicker, 1994, Textbook of microbiology Orient Longman.
3. Chakraborty P 1995, A Text book of microbiology, New Central Book Agency Pvt Ltd. Calcutta.
4. Bailey and Scotts, 1994, Diagnostic Microbiology, 9th edition, Baron and Finegold CV Mosby Publications.
5. Jawetz E Melnic JL and Adelberg EA 1998, review of Medical Microbiology Lange Medical Publications, USA

ELECTIVE II – B : MEDICAL BIOCHEMISTRY

Unit I

Disorders of carbohydrate metabolism – Diabetes mellitus, Glucose tolerance tests, sugar levels in blood, renal threshold for glucose, factors influencing blood glucose level, glycogen storage diseases, pentosuria, galactosemia

Unit II

Disorders of lipids- Plasma lipo proteins, cholesterol, triglycerides and phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Gaucher's disease, Tay-Sach's, ketone bodies, β -lipoproteinemia

Unit III

Disorders of liver and kidney- Jaundice, fatty liver, normal and abnormal functions of liver and kidney, inulin and urea clearance

Unit IV

Abnormalities in nitrogen metabolism- Uremia, hyperurecemia, porphyria and factors affecting nitrogen balance

Unit V

Blood –composition and functions, properties and functions of haemoglobin. Blood clotting- disturbances in blood clotting mechanisms- haemorrhagic disorders, haemophilia, purpura, thrombocytopenic purpura, disseminated intravascular coagulation, acquired prothrombin complex disorders, circulating anticoagulants.

References

1. Fundamentals of biochemistry. A. C. Deb. 8th edition. New central book agency (p)ltd. India
2. Textbook of biochemistry with clinical correlations. Thomas M Deblin. 4th edition. A John Wiley and sons, Inc., publications., New York.
3. Biochemistry. U. Sathyanarayana. 2nd edition. Books and allied pvt ltd.
4. Fundamental of Biochemistry for medical students. Ambika Shanmugam. Revised edition(2003). Published by the Author, 17. III Cross street, west CIT nagar, Chennai-35

ELECTIVE II – C : PLANT BIOTECHNOLOGY

UNIT – I

Plant Tissue culture – History, Plant tissue culture media, types, constituents and preparation of media, selection of suitable medium.

UNIT – II

Protoplast culture and somatic hybridization, production of Haploid plants, Somaclonal variations, Clonal propagation (micro propagation) germplasm conservation and cryopreservation.

UNIT – III

Genetic Engineering of plants – Gene transfer methods – vector mediated gene transfer, virus – mediated gene transfer, Direct or Vectorless DNA transfer.

UNIT –IV

Application of Transgenic plants – Resistance to biotic stresses – Insect resistance plant virus, bacteria and fungi resistance, abiotic stress – herbicide resistance plants.

UNIT – V

Molecular Marker Aided plant Breeding – Molecular markers, Molecular marker assisted selection, Arid & semi-arid plant Biotech, Green house & Green home technology.

References:

Dr. U. Sathyanarayana – Biotechnology. Books and Allied Publications

Winnacker, E.L. 1989: From genes to clones. Introduction to Gene Technology. VCH Weinheim.

Old, R.M. and S.B. Primrose. 1995. Principles of Gene Manipulation. Blackwell Scientific Publication. London.

Glick, B.K. and Pasternak, J.J. 1994. Molecular Biotechnology. Principles and applications of recombinant DNA. ASM Press, Washington.

ELECTIVE III - A

MEDICAL MICROBIOLOGY - II

UNIT- I

Mycology: superficial infections- *Dermatopytes*- *Microsporum* – *Trichophyton*, *Epidermophyton*- *Madura mycosis*- Opportunistic fungal infections- *Candida Albicans*, *Aspergillus*, *Mucor*.

UNIT -II

Parasitic diseases- *Plasmodium vivax*, *Giardia*, *Taenia solium*, *Ancylostoma*, *Ascaris*, *Wuchereria bancrofti*, *Enterobius*, *Trichuris trichura*.

UNIT -III

Etiology and laboratory diagnosis of urinary tract infection- fever of unknown Origin meningitis, diarrhea, respiratory tract infections.

UNIT -IV

Pyogenic infections- *Staphylococcus* and *Pseudomonas*: sexually transmitted diseases, nosocomial infections-definition, sources and detection; phage typing, bacteriocin typing.

UNIT -V

Antibiotics and chemotherapeutic agents- Mechanism of actions – Drug resistance – Antimicrobial susceptibility testing- Disc diffusion- Kirby Bauer method.

References

1. Mackie and McCartney, 1994, Medical Microbiology, Voll and II Churchill Livingston .
2. Ananthanarayanan, R and C K Jayaram Panicker, 1994. Textbook of Microbiology, Orient Longman.
3. Bailey and Scotts, 1994 Diagnostic Microbiology 9th edition Baron and Finegold, C V Moshby Publications.
4. Jayaram Panicker, C K 1993 3rd edition Text book for Medical Parasitology, Jaypee Brothers Medical Publishers (P) Ltd.
5. Rajesh Karyakarte and Ajith Damle (2005)Medical Parasitology, ooks and Allied(P)Ltd.

ELECTIVE III – B : ENTREPRENEURIAL MICROBIOLOGY

UNIT I:

Entrepreneur development, activity, Institutes involved, Government contributions to entrepreneurs, risk assessment. Industrial Microbiology, Definition, scope and historical development.

UNIT II:

Microbial cells as fermentation products- Bakers yeast, food and feed yeasts, Bacterial Insecticides, Legume Inoculants, Mushrooms, Algae. Enzymes as fermentation products- Bacterial and Fungal Amylases, Proteolytic Enzymes, Pectinases, Invertases, and other enzymes.

UNIT III:

Mushroom cultivation and Composting- Cultivation of *Agaricus campestris*, *Agaricus bisporus*, and *Volvariella volvaciae*; Preparation of compost, filling tray beds, spawning, maintaining optimal temperature, casing, watering, harvesting, storage. Biofertilizers- Historical background, Chemical fertilizers versus biofertilizers, organic farming. *Rhizobium* sp, *Azospirillum* sp, *Azotobacter* sp, as Biofertilizers.

UNIT IV:

Patents and secret processes, History of patenting, composition, subject matter and characteristics of a patent, Inventor, Infringement, cost of patent. Patents in India and other countries. Fermentation Economics.

UNIT V:

Brewing- Media components, preparation of medium, Microorganisms involved, maturation, carbonation, packaging, keeping quality, contamination, by products. Production of Industrial alcohol.

References:

Industrial Microbiology- L.E.Casida, jr, New age International publication.
Entrepreneurial Development in India- By Arora
Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom production technology- K.R.Aneja, New age International publication.

ELECTIVE III – C : BIONANOTECHNOLOGY

Unit I:

Introduction- Definition, about Bionanomachines, Molecular Bionanotechnology. History of Bionanotechnology; Richard Feynman and his contributions. Biotechnology versus Bionanotechnology. Natural Bionanomachines.

Unit II:

Structural Principles of Bionanotechnology-Environment in which the Bionanomachines Functions. Principles behind design of Natural Bionanomachines- Covalent bonding, Dispersions and repulsion forces. Hydrogen bonding, Electrostatic Interaction, Hydrophobic effect. Hierarchical strategy in construction of Bionanomachines - Self-assembly, Self-organization. Concept of Molecular recognition.

Unit III:

Functional Principles of Bionanotechnology- Information storage- Nucleic acid, Ribosomes as assembler to construct proteins. Energetics- Energy from Light, electron transport pathways, electrochemical gradient. Biocatalysts- Enzymes and its regulation. Biomaterials. Biomolecular motors. Molecular sensing- Biosensors.

Unit IV:

Tools and technique required for Bionanotechnology- Recombinant DNA technology; site directed mutagenesis, Fusion proteins. X-Ray Crystallography, NMR, Electron Microscopy, Atomic force Microscopy. Bioinformatics- Molecular Modeling, Docking, Computer assisted Molecular design.

Unit V:

Applications of Bionanotechnology- Nanomedicines; Immunotoxins, Liposomes as drug carriers, Gene therapy, Personalised Medicines; Lab on chip concept. DNA Computers, Artificial Life, Hybrid materials, Biosensors.

References:

Goodsell - Bionanotechnology

Parag Diwan and Asish Bharadwaj, . - Nanomedicines Pentagon Press, 2006.

Vladimir P Torchilin, Nanoparticles as Drug Carriers. Imperial College Press, North Eastern University, USA. 2006