S.N.D.T. WOMEN'S UNIVERSITY
MUMBAI

PROPOSED CURRICULAM

M.Sc. Microbiology

FOUR SEMESTER PROGRAMME

Effective from Academic Year 2015-16

M. SC. in MICROBIOLOGY is a FOUR semesters, TWO year course.

ADMISSION CRITERIA:

Only Female candidates shall be admitted. A student seeking admission to M.Sc. Programme in Microbiology must fulfill the following criteria:

1. The candidate should have Bachelors degree under 10+2+3 pattern of education* with Microbiology as Principal subject with at least 50% marks as aggregate of all the semesters / years.
2. The candidate having Bachelors degree under 10+2+3 pattern of education* with Chemistry, Biochemistry, Botany, Zoology, Life Sciences, Environmental Sciences, Bio-technology with Microbiology at subsidiary level with at least 50% marks as aggregate of all the semester / years.

*B. Sc. with 5 units of 4 credits each (Annual System) or B. Sc. with 32 credits (Semester System) of Microbiology.

SCHEME: M.Sc.in Microbiology Total Credits -96

Course structure:

SEMESTER I

Paper	Title	Hrs /wk	Internal	External	Total Marks	Credits
1001	Medical Microbiology & Immunology	4	50	50	100	4
1002	Cell biology	4	50	50	100	4
1003	Bioenergetics & Microbial Biotechnology	4	50	50	100	4
1004	Microbial Genetics	4	50	50	100	4
1005	Cell biology & Medical Microbiology (Practical)	8	50	50	100	4
1006	Microbial Biotechnology & Genetics (Practical)	8	50	50	100	4
				Total	600	24

SEMESTER II

Paper	Title	Hrs/ wk	Internal	External	Total Marks	Credits
2001	Tools & Techniques of Biomolecular analysis	4	50	50	100	4
2002	Advanced Virology	4	50	50	100	4
2003	Microbial Biochemistry	4	50	50	100	4
2004	Research Methodology	4	50	50	100	4
2005	Tools & Techniques of Biomolecular analysis (Practical)	8	50	50	100	4
2006	Advanced Virology & Biochemistry (Practical)	8	50	50	100	4
				Total	600	24

SEMESTER III

Paper	Title	Hrs/ wk	Internal	External	Total Marks	Credits
3001	Food & Dairy Microbiology	4	50	50	100	4
3002	Industrial and Environmental Microbiology	4	50	50	100	4
3003	Bioprocess Engineering & Technology	4	50	50	100	4
3004	Elective Paper	4	50	50	100	4
3005	Food & Dairy Microbiology (Practical)	8	50	50	100	4
3006	Environmental Microbiology & Bioprocess Technology (Practical)	8	50	50	100	4
				Total	600	24

SEMESTER IV

Paper	Title	Hrs/ wk	Internal	External	Total Marks	Credits
4001	Advanced Biotechnology	4	50	50	100	4
4002	Advanced Biotechnology (Practical)	8	50	50	100	4
4003	Research Project (9 weeks)	12	100	100	200	8
4004	In-plant training (6 weeks)	40	100	100	200	8
				Total	600	24

25 Marks, 1 Credit, 15 hrs (1 Lecture = 1 hr)

Semester I+ II + III + IV = 96 Credits Course

Electives

1. Pharmaceutical Microbiology
2. Enzyme Technology
3. Bioinformatics & Proteomics

Methodology

1. Lectures, Tutorials
2. Self study/ Internet/ Websites
3. Home assignments

Internal Assessment (Any One)

1. Presentation on one of the topic from the text
2. Community extension work
3. Field survey

Semester I

SEMESTER I

Course I: 1001: **Medical Microbiology & Immunology**

The course is divided into 4 modules of **one credit each** with 15 instructional hrs/module

Objectives: Medical Microbiology and Immunology are the important aspects of Microbiology. Thorough knowledge of these topics is essential for the following reasons:

1. To describe the importance of various pathogenic microorganisms and the diseases caused by them.
2. To define the various biochemical tests for detection of pathogens that help in diagnosis of diseases caused by them.
3. To recognize the basic principles of immunology and to know the immune response of host.
4. To understand the diagnostic techniques of various immunological diseases.

Module 1	**Advances in Medical Microbiology**	**1 credit**
Contents	**Topics covered**	Hrs
	Emerging Diseases :-Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab. diagnosis, Prophylaxis, and Treatment:- MOTT (Mycobacteria other than TB), Leptospirosis Legionellosis, Leishmaniasis, Trypanosomiasis, Filariasis AIDS , Chickungnuya, Dengue Cholera caused by *V. cholerae* Conditions caused by *Helicobactor pyloari*, SARS.	2 4 4 2 1 2

Module 2	**Epidemiology of infectious diseases and Modern diagnostics in Clinical Research**	**1 credit**
Contents	**Topics covered**	Hrs
	Epidemiology of infectious diseases: Historical aspects-definition, Descriptive Epidemiology-aims and uses, principals in prevention and control of Diseases. **Measures of risks**: frequency measures, morbidity, frequency measures, mortality frequency measures, natality (birth) measures, measures of association, measures of public health impact. **Public health surveillance**: purpose and characteristics, identifying health problems for surveillance, collecting data for surveillance, analyzing and interpreting data, disseminating data and interpretation, evaluating and improving surveillance. **Clinical Research:** Introduction to Clinical Research, Good Clinical practice Guidelines, Ethical aspects of Clinical Research, Regulatory Requirements in clinical research, Clinical Research Methodologies and Management	3 3 3 3

	Clinical Data Management and Statistics in Clinical research**.** **Modern Diagnostic Methods***,* Advances in Molecular and Immunological Techniques, Microarrays, Advances in Fluorescence Technology.	3

Module 3	**Immune System and Antigen- Antibody reactions**	**1 credit**
Contents	**Topics covered**	Hrs
	Immune System Organs and cells involved in immune system and immune response. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors of lymph cells, helper T cells suppression lymphocyte trafficking..	2 3
	Antigens and Immunoglobulin Concept of hapters, determinants, conditions of antigenicity, antigens and immunogenicity, superantigen. Immunoglobulins Structure and properties of immunoglobulin classes. Theories of antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies. Multiple mylomas and structural basis of antibody diversity.	2
	Antigen – Antibody reactions Antigen – Antibody reactions by precipitation, agglutination and complements fixation. **Non – Specific immune mechanism**:- surface defenses, tissue defenses, opsonization, Inflammatory reaction, and hormone balance. Tissue matabolites with bactericidal properties (Lysozme, nuclein, histone, protamine, basic peptides of tissues – leukins, phagocytins, lecterins, haemocornponds)	5
	Expression and Regulation of Immune Response Regulations of immune response – antigen processing and presentation, generation of humoral and cell medicated immune response, activation of B and T lymphocytes, cytokines and there role in immune regulation, T cell regulation, MHC registration, immunological tolerance. Cell mediated cytotoxity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxity, and macrophage mediated cytotoxity. Complement system classical, alternate, lectin pathway of complement activation. Regulation of Complement activation. Transplantation immunology. MHC, types of grafts, grafts rejections, mechanism of graft rejection, and prevention of graft rejection.	3
	Immunity and immunoassays	

	Defense against bacteria, viruses, fungi and parasites, immunodiagnostics and immunotherapy in virology – serological methods for detections and quantitation of viruses including Hepatitis, Influenza HIV and others. Immuno-assays : SRID. ELISA, ELISA –PCR, RIA , Western Blotting Immunofluroscense and their applications, immune deficiencies and autoimmunity.	

Module 4	**Recent advances in Immunology and Challenges in Immune System**	**1 credit**
Contents	**Topics covered**	Hrs
	Recent advances in immune tolerance and autoimmunity	2
	Transplantation & Transfusion Immunology	2
	Cancer immunology and Cancer Immuno Therapy	2
	Challenges in immune system - Recent advances in vaccines - Challenges faced, HIV, Measles, T.B.	
	Immunodeficiency diseases - Primary Immunodeficiency, Defects in the Complement System, Treatment Approaches for Immunodeficiency, Animal Models of Primary Immunodeficiency, Secondary Immuno-deficiency & AIDS	3 3
	Adversarial strategies to overcome immune response -microbial strategies in relation to the immune response, Inflammation Revisited, Protective Response Against Bacteria, The Habitat of Intracellular Bacteria, Immunity to Fungi, Immunity to Parasitic Infection	3

Reference books	
	1. Mackie & McCartney Practical Medical Microbiology. Edited by J. G. Collee, J. P. Duguid, A. G. Fraser and B. P. Marmion, Thirteenth Edition, Churchil Livingstone. (1989) 2. Tortora G. J. Microbiology: An Introduction, Benjamin Cumming Corp.1st edition, (2008) *3.* Samuel Baron, Medical Microbiology, 4th edition*, 1996,* 4. *J.C.H. Steele,* Clinics in laboratory medicine, Emerging Infections and their causative agents. vol 24,issue 3, September (2004) 5. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition (2009) 6. Godkar Praful, Medical laboratory technology, 2nd edition. (2006) 7. W. Ahrens, I. Pigeot, Handbook of Epidemiology- W. Ahrens, I. Pigeot Springer- Verlag Berlin Herdelberg (2005). 8. Robert H Friis & Thomas A. Sellers, Epidemiology for Public Health Practice-3rd edition-Jones & Bartlett publishers.(2003) 9. Park & Park, Textbook of preventive and Community medicine, 3rd Edition (2011) 10. Nikuchia Nikanath, Infectious disease surveillance, a Blackwell Publishing, 2005. 11. Richard Dicker, Principles of epidemiology in public health practices 3rd edition, (2006)

	12. Riott I.M., Essentials of immunology, Ej.BS. Blackwell Scientific Publishers, London 12th edition(1998) 13. Kuby J., Immunology, W.H. Freeman and co. New york, 2nd edition (1994). 14. Claus D. Elgert, Immunology – Understanding of immune Systerm by Wiley- Liss New York, (1996) 15. William Paul, Fundamentals of Immunology, 5th edition, (2003) 16. Immunology – Essential and Fundamental, Sulabha Pathak and Urmi Palan. 3rd edition, (2011) 17. Kuby, Immunology- 6th edition W. H. Freeman and company- New York.(2007) 18. Fahim Halim Khan, The Elements of immunology- - Pearson Education, 1st Edition (2009) 19. Ian R. Tizard-Thomson Immunology an introduction- 4th edition-, 8th edition, (2008) 20. Travers. GS., Immunobiology –the immune system in health and disease 6th ed, (2005)

*Course II: 1002***: Cell biology**

The course is divided into 4 modules of **one credit each** with 15 instructional hrs/module

Objectives: Cell biology is an integral part of Microbiology. Thorough knowledge of cell organelle and their functions is essential for the following reasons:

1. To describe and discuss importance of structure of cell membrane of microorganisms and their functions.
2. To recognize and to outline the mechanisms of cell respiration, transport through membrane and photosynthesis.
3. To distinguish the process of cell division and the changes occurring during the process.
4. To outline the various ways of cell communication.

Module 1	**Membrane Structure & Transport**	**1 credit**
Contents	**Topics covered**	Hrs
	Bacterial Permeation Structure & organization of membrane (Glycol – conjugants & proteins in membrane systems), fluid mosaic model of membrane. Methods of study diffusion of solutes in Bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (proton Motive Force, PTS, role of permeases in transport, different permeases in E.coil. Transport of amino acids & inorganic ions in microorganisms & their Mechanisms.)	4
	Bacterial Sporulation Sporulation bacteria, molecular architecture of spores, induction & stages of sporulation, influence of different factors on sporulation. Cytological &	3

	macromolecular changes during sporulation. Heat resistance & sporulation.	
	Bacterial Chemolithotrophs Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso groups, nitrite oxidation by Nitro group of genera. Oxidation of molecular hydrogen by *Hydrogenomonas* species. Ferrous & sulfur/sulfide by *Thiobacillus* species.	2
	Cell membrane structure : Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins Bacteriorhodopsin Membrane Transport: Principles of membrane transport, ion channels and electrical properties of membranes.	3
	Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, peroxisomes, Endoplasmic reticulum, transport of proteins into mitochondria and chloroplasts Intracellular vesicular traffic : Endocytosis, exocytosis, transport from the ER through the Golgi apparatus.	3

Module 2	Eucaryotic cell Respiration & Photosynthesis	1 credit
Contents	**Topics covered**	Hrs
	Eucaryotic cell Photosynthesis Chloroplasts : Structure, energy capture from sunlight, genetic system, Photosynthesis Microorganisms, photosynthetic pigments and generation of reducing power by cyclic & noncyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways.	4
	Respiration Bacterial aerobic respiration, Mitochondria: Structure, electron-transport chains and proton pump, components of electron transport chain, free energy changes & electron transport, oxidative Phosphorylation & theories of ATP generation, inhibition of electron transport chain. Electron transport chain in some heterotrophic & chemolithotrophic bacteria.	4
	Cytoskeleton: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors, cell behavior.	3
	Cell study : Study of cells under the microscope, Phase contrast, Fluorescence microscopy , Confocal microscopy & electron microscopy.	4

Module 3	Cell division and Cell cycle	1 credit
Contents	**Topics covered**	Hrs
	Mechanism of cell division : M-phase, Mitosis, Cytokines	3
	Cell cycle and Programmed cell death : Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis	5
	Cell Junctions and cell adhesion: Anchoring, adherence junctions, Desmosomes, Gap junctions, cell-cell adhesion, Cadherins	3
	Development of multicellular organisms: Animal cell development, *Caenorhabditis elegans*, Drosophila signalling genes, gradient of nuclear gene regulatory protein, Dpp and Sog set up, Neural development	4

Module 4	Cell Communication	1 credit
Contents	**Topics covered**	Hrs
	Germ cells and fertilization, Meiosis, sex determination in mammals, eggs, sperm, fertilization. Cell communication : Extracellular signal molecules, nitric oxide gas	4

	signal, classes of cell-surface receptor proteins. Signaling through enzyme linked cell surface receptors : Docking sites, Ras , MAP kinase, Pl-3 kinase, TGF. Signaling in plants : Serine / Threonine kinases, role of ethylene, Phytochromes.	5 3 3

Reference books	1. Caldwell D.R, Microbial physiology & metabolism by 5th edition, Brown publishers(1990) 2. W. V. Shimkots, Moat A.G. & Foster J.W, Microbial physiology, 3rd edition, Wiley,(1999) 3. Brun. W. V. Shimkots I.J, Prokaryotic Development, ASM. Press, (2000) 4. A.H. Rose, Advances in Microbial physiology, Vol. 17, Academic Press, New York (1978). 5. P. M. Rhodes and P. F. Stanbury, Applied Microbial physiology, IRL Press, (1997) 6. I.C. Gunsalus & Rogery Stainer, The Bacteria. Volume I, by Academic press (1960) 7. Albert, Johnson, Lewis, Raff, Roberts & Walter, Molecular Biology of The Cell, 4th edition, (2002) 8. Lodish , Birk, and Zipursky. Freeman, Molecular Cell Biology, 4th edition, New York, (2000) 9. Lipowsky and Sackmann, The Structure and Dynamics of Cell Membrane, 1st edition, Elsevier, (1995) 10. Cell Movements : from Molecules to Motility- Bray Garland Pub. New York, (2001)

Course II: 1003: **Bioenergetics & Molecular Enzymology**

The course is divided into 4 modules of **one credit each** with 15 instructional hrs/module

Objectives: Bioenergetics and molecular Enzymology is an important area of Microbiology. Thorough knowledge of this area is essential for the following reasons:

1. To describe various catabolic pathways of Carbohydrate and biosynthesis of intermediates.
2. To discuss and learn about bacterial fermentations.
2. To understand the endogenous metabolism and to list pathways of degradation of organic compounds.
3. To study different pproperties of enzymes.
4. To discuss the Enzyme kinetics and its applications.

Module 1	Carbohydrate catabolic pathways, biosynthesis and bacterial fermentations	1 credit
Contents	**Topics covered**	Hrs
	Carbohydrate catabolic pathways & microbial growth on CI Compounds : EMP, HMP shunt, ED, phospoketolase pathway, TCA cycle, methylglyoxal bypass. Anaplerotic sequences, catabolism of different carbohydrates, glycerol metabolism, regulation of carbohydrate metabolism, Pasteur effect, Substrate level phospsorylation. Microbial growth on CI compounds (Cyanide, Methane, Methanol, Methylated Amines and carbon monoxide).	6
	Bacterial fermentations (biochemical aspects) Alcohol, lactate, mixed acids, acetone-butanol, propionic acid, succinate, methane and acetate fermentation of single nitrogenous compounds, Amino acids – alanine, glutamate and glycine.	5
	Biosynthesis of Purines, Pyrimidines and fatty acids.	4

Module 2	Endogenous metabolism and degradation of organic compounds	1 credit
Contents	**Topics covered**	Hrs
	Endogenous metabolism: Functions of endogenous metabolism, types of reserve materials, enzymatic synthesis, degradation and regulation of reserve materials - glycogen, polyphosphates and polyhydroxy butyrate (PHB), PHB production and its futuristic applications.	7
	Degradation of aliphatic and aromatic compounds Microbial degradation of aliphatic hydrocarbons (microorganisms involved, mono-terminal, bi-terminal oxidation of propane, decane, etc.) and aromatic hydrocarbons and aromatic compounds (via catechol, photocatechtunate, meta-cleavage of catechol and protocatechture, dissimilation of catechol and protocatechunate, homogentisate and related pathways).	8

Module 3	Properties of enzymes	1 credit
Contents	**Topics covered**	Hrs
	Classification of enzymes into six major groups with suitable examples. Numerical classification of enzymes.	2
	Different structural conformation of enzyme proteins.	3

	Enzymes as biocatalysis, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action. Mechanisms of action of lysozyme, chymotrypsin & ribonuclease.	5
	Monomeric, oligomeric & multienzyme complex, isozymes & allosteric enzymes.	3
	Extremozymes- thermostable, solventogenic & non-aqueous enzymes. Ribozymes & abzymes.	2

Module 4	**Enzyme kinetics**	**1 credit**
Contents	**Topics covered**	Hrs
	Importance of enzyme kinetics.	3
	Factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration & reaction time).	3
	Derivation of Michaelis-Menton equation & its significance in enzyme kinetic studies.	4
	Modifications of Michaelis-Menton equation - Lineweaver-Burke plot, Haldane-Bringgs relationship, sigmoidal kinetics steady state kinetics & transient phases of enzyme reaction. Enzyme kinetics and enzyme inhibition studies.	5

Reference books	1. Trevor Palmer, Understanding enzymes, 4th edition, Prentice Hall Publishers,(1995) 2. Paul Engel, Enzyme kinetics, John Wiley & Sons, Inc. New York (1977) 3. Dixon & Webb, Enzymes, 3rd Edition, Academic Press, New York, (1979) 4. Lubert Stryer, Biochemistry, 5th edition, WH Freeman, (2002) 5. T. S. Work and E. Work, Laboratory techniques in Biochemistry & Molecular Biology, Part2, (1976) 6. Athel Cormish, Principles of Enzyme Kinetics, Bowden. Butterwoth & Co. (1976) 7. G R Chatwal, Biochemistry, 5th edition, Himalaya Publishing House, (2012) 8. Reginald H Garret, Biochemistry, 4th edition, (2010) 9. Donald Voet, Judith G. Voet, Biochemistry, 4th edition, Wiley, (2010) 10. Russell Doolittle, Methods in Enzymology, vol. 266, (1997) 11. Methods of Biochemistry Analysis by David Glick, Vol. 25, John Willey & Sons, New York, (1979)

Course IV: 1004 : Microbial Genetics

The course is divided into 4 modules of **one credit each** with 15 instructional hrs/modules.

Objectives: Microbial genetics is an integral part of Microbiology. Thorough knowledge of these topics is essential for the following reasons: 1. To describe and to relate the expression and regulation of genes. 2. To illustrate Cytoplasmic inheritance and Chromosomal Rearrangements. 3. To understand the mechanisms of Viral Genetics. 4. To outline various types of developmental Genetics.		
Module 1	**Gene expression and regulation**	**1 credit**
Contents	**Topics covered**	Hrs
	Gene Expression: RNA molecules and processing, Post transcriptional processing- structure of mRNA, pre mRNA processing, addition of 5'cap, addition of Poly(A) tail, RNA splicing, RNA editing, Small RNA molecules- RNA interference, types, processing & function of micro RNAs.	3 2
	Translation process-mechanism of translation, charging of t-RNA molecules, initiation, elongation and termination, mRNA surveillance. Post translational modification of proteins. **Regulation of gene expression** A. **Control of gene expression in prokaryotes**. Transcription process in prokaryotes, Genes & regulatory element, Levels of gene regulation, DNA binding proteins, Antisense RNA molecules, Riboswitches.	2
	Operon Concept, coordinated control structure genes, Lac operon - Trp operon, L-arabinose operon, Gal operon Repressor proteins & their functions. B**. Control of gene expression in eukaryotes**. Transcription process in eukaryotes, Regulation through modification of gene structure- DNase, hypersensitivity, histone modifications, chromatin remodelling, DNA methylation.	2 2
	Regulation through transcriptional activators of gene expressions, Co activators & repressors, enhancers and insulators, Regulation through RNA processing & degradation, Regulation through RNA interference, Identifying gene under common regulations, Gene activation silencing, Translational control. **Replication, recombination, mutation and repair** Regulation of replication, Recombination, Mutation, Molecular basis of mutation, Screening chemicals for mutagenicity (Ame's test), DNA repair mechanisms-Types of repair mechanisms, Inherited human diseases with defects in DNA repair.	3 3

Module 2	Cytoplasmic Inheritance	1 credit
Contents	**Topics covered**	Hrs
	Cytoplasmic Inheritance (Organellar Genetics) A. mt-DNA - Mitochondrial genome structure, Ancestral and derived mitochondrial genome, Mitochondrial DNA of Human, yeast and flowering plants, Endosymbiotic theory, Mitochondrial DNA replication, transcription & translation, Codon usage in Mitochondria, Damage to Mitochondrial DNA and aging, Evolution of Mitochondrial DNA, mt DNA analysis for study of evolutionary relationships	5
	B. cp DNA - Gene structure and organization, General features of replication, transcription and translation of cp DNA, Comparison of nuclear, eukaryotic, eubacterial, mitochondrial and chloroplast DNA, Examples of extra nuclear inheritancev, Leaf Variegation, Poky mutant of Neurospora, Yeast petite mutant, Human genetic diseases, Maps of mt DNA and cp DNA	5
	Chromosomal Rearrangements and effects on gene expression A. Amplification and deletion of genes B. Inversions that alter gene expression C. Transpositions that alter gene -Expression antigenic variation in Trypansomes, Mating type switching in yeast, Phase variation in Salmonella	5

Module 3	Viral Genetics and gene transfer	1 credit
Contents	**Topics covered**	Hrs

	Viral genetics 1. Mapping the Bacteriophage genome- Phage phenotypes, Genetic recombination in phages, Genetic fine structure mapping, Deletion mapping 2. Genes within genes : Bacteriophage Φ X174 3. Constructing phage vectors- phage display vectors, suicide vectors, combining phage vectors and transposons	5
	Gene Transfer 1. Drug resistance and gene transfer in bacteria. 2. Genetic exchange in Bacteria – An overview 3. Mutant phenotypes in bacteria 4. Basic test for transformation, conjugation and transduction	3
	Transposable genetic elements 1. Transposable Elements in Prokaryotes- An Overview, The medical Significance of Bacterial Transposons 2. Transposable Elements in Eukaryotes- Ac and Ds Elements in Maize, P Elements and Hybrid Dysgenesis in Drosophila, Mariner, an Ancient and Widespread Transposon 3. Retrotransposons- Retroviruslike Elements, Retroposons 4. The Genetic and Evolutionary Significance of Transposable Elements- Transposons and Genome Organization, Transposons and Mutation, Rearrangement of Immunoglobulin Genes, Evolutionary Issues Concerning Transposable Elements	4
	Genetic basis of cancer 1. Cancer- A Genetics Disease, The Many Forms of Cancer, Cancer and the Cell Cycle, A Genetics Basis for Cancer 2. Oncogenes- Tumor-Inducing Retroviruses and Viral Oncogenes, Cellular Homologs of Viral Oncogenes: The Proto-Oncogenes, Mutant Cellular Oncogenes and Cancer, Chromosome Rearrangement and Cancer 3. Tumor Supressor Genes- Inherited Cancers and Knudson's Two-Hit Hypothesis, Cellular Roles of Tumor Suppressor Proteins 4. Genetic Pathways to Cancer	3

Module 4	**Developmental Genetics**	**1 credit**
Contents	**Topics covered**	Hrs
	Developmental genetics A. Cloning Experiments B. The Genetics of Pattern Formation in Drosophila C. Homeobox Genes in other Organisms D. The Genetics of Flower Development in Arabidopsis E. Programmed Cell Death in Development F. Evo-Devo: The Study of Evolution and Development	2
	The genetic control of animal development A. Stem Cell Therapy: A Brave New World?	3

	B. The Process of Development in Animals- Oogenesis and fertilization, The Embryonic Cleavage Divisions and Blastula Formation, Gastrulation and Morphogenesis C. Genetic Analysis of Development in Model Organisms- Drosophila as a Model Organism, Caenorhabditis as a model organism D. Genetic Analysis of Development Pathways- Sex Determination in Drosophila, Sex Determination in Caenorhabditis E. Molecular Analysis of Genes Involved in Development F. Maternal Gene Activity in Development- Maternal-Effect Genes, Determination of the Dorsal-Ventral and Anterior-Posterior Axes in Drosophila Embryos G. Zygotic Gene Activity in Development- Body Segmentation, Specification of Cell Types, Organ Formation	
	Applications and ethics of genetic technology A. Mapping Human Genes at the Molecular Level- RFLPs as Genetic Markers B. Linkage Analysis Using RFLPs C. Positional Cloning- The Gene for Neurofibromatosis D. The Candidate Gene Approach- The Gene for Marfan Syndrome E. Fluorescent in Situ Hybridization (FISH) Gene Mapping	2 2
	Genetic Disorders: Diagnosis and Screening Prenatal Genotyping for Mutations in the β- Globin Gene, Prenatal Diagnosis of sickle-Cell Anaemia, Single Nucleotide Polymorphisms and Genetic Screening, DNA Microarrays and Genetic Screening, Genetic Testing and Ethical Dilemmas	
	Treating Disorders with Gene Therapy Gene Therapy for Severe Combined Immunodeficiency (SCRID), Problems and Failures in Gene Therapy, The Future of Gene Therapy: New Vectors and Target-Cell Strategies, Ethical Issues and Gene Therapy	2
	DNA Fingerprints A. Minisatellites (VNTRs) and Microsatellites (STRs) B. Forensic Applications of DNA Fingerprints	 1
	Genome Projects Use Recombinant DNA technology A. The Human Genome Project: An overview B. The Ethical, Legal, and Social Implications (ELSI) Program C. After the Genome Projects	1
	Biotechnology is an Outgrowth of Recombinant DNA Technology A. Insulin Production by Bacteria B. Transgenic Animal Hosts and Pharmaceutical Products C. Transgenic Crop Plants and Herbicide Resistance	2
	Marshalling recombinant DNA technology to fight AIDS	1

Reference books	1. Benjamin Pierce, Genetics: A Conceptual Approach, 3rd Edition by W. H. Freeman (2008) 2. R. F. Weaver, Gene X – Lewin Molecular Biology, 5th edition, McGraw-Hill. (2012) 3. D. Peter Snustad & Michael J. Simmons, Principles of Genetics, 3rd edition, Wiley, (2002) 4. Nancy Trun and Janine Trempy, Fundamental Bacterial Genetics, Chapters 8,10 and 11, Blackwell Science, 2004 5. William S. Klug & Michael R.Cummings, Concept of Genetics, eleventh edition, (2014) 6. J.D. Watson, Recombinant DNA, 2nd edition, W. H. Freeman, (1993) 7. Watson, Molecular biology of the gene 6th edition, (2007)

Course V **1005 : Cell biology & Medical Microbiology Practical**

The course is divided into 4 modules of **one credit each** with 15 instructional hrs/module

Objectives: Medical Microbiology, Immunology and cell biology are the important aspects of Microbiology. Thorough knowledge of these topics is essential for the following reasons:

1. To describe the importance of various pathogenic microorganisms and the diseases caused by them and to define the various biochemical tests for detection of pathogens that help in diagnosis of diseases caused by them.
2. To recognize the basic principles of immunology and to know the immune response of host and to understand the diagnostic techniques of various immunological diseases.
3. To describe and discuss importance of structure of cell membrane of microorganisms and their functions.
4. To recognize and to outline the mechanisms of cell respiration, transport through membrane and photosynthesis and to outline the various ways of cell communication.

		1 credit
Contents	**Experiments**	Hrs
	Some of the following experiments/assignments will be conducted: 1)Isolation and Purification of coliphages from sewage. 2) Phage Typing of E. coli and Salmonella strains. 3) Study of One Step Growth Curve of Lambda phage / T4 Phage. 4) Study of Lysogeny in *E. coli*. 5) Assignment on Virology – Research Paper. 6) Isolation of Lysozyme from egg white. 7) Preparation of protoplast using Lysozyme. 8) Demonstration- i) Study of cell cytology using Phase contrast Microscopy. ii) Study of Cell structure using Confocal Microscopy. iii) Study of Cell structure using Fluorescence Microscopy. iv) Egg inoculation and cultivating animal virus in embryonated egg.	

	Demonstration 9)Isolation of Mitochondria from the cell. 10) Cultivation of macrophage cell lines and study of cell viability 11) Study of Mitosis. 12) Study of Meiosis 13) Estimation of NO (Nitric Oxide) produced by Macrophages. 14) Study of Phagocytosis using bacterial culture / yeast cells 15) Study of Cell membrane integrity using uptake of neutral red. 16) Writing Research Paper –w.r.t. Techniques used to study cell cycle. 17) Review on Cell – Cell communication. 18) Assignment on Animal viruses – Epidemiology, Transmission 19) Problem solving exercises in medical microbiology based on diseases caused by- HIV, MOTT, Chickengunya, Helicobacter, *Vibrio cholerae* 0139. 20) Diagnosis for HIV 1.CD4 lymphocyte count for AIDS 2.ELISA for AIDS, 21) Diagnosis for MOTT 3.Acid fast staining for MOTT 4.Mono-Spot Test for diagnosis of Chickengunia (Demonstration expt.) 22) Diagnosis for V.c.0139 5.Cholera red test, String test, Oxidase test, Biochemical tests, & isolation on TCBS medium for identification of Vibrio cholerae 0139. 6.serological diagnosis for V.c.0139 using specific monotypic antisera 23. Diagnosis for *Helicobacter pyolari* 7. HPSA (*Helicobacter pyolari*) detection from stool sample. (Demonstration expt.) (kit method) 8..Study of virulence factors-Phagocytosis & Phagocytic index 9.Collection of human blood & separation of mononuclear cells by ficoll hypaque density gradient centrifugation, 10. Counting of viable cells by trypan blue.	

Reference books	1. Mackie & McCartney Practical Medical Microbiology. Edited by J. G. Collee, J. P. Duguid, A. G. Fraser and B. P. Marmion, Thirteenth Edition, Churchil Livingstone. (1989) 2. Tortora G. J. Microbiology: An Introduction, Benjamin Cumming Corp.1st edition, (2008) *3.* Samuel Baron, Medical Microbiology, 4th edition*, 1996,* 4. *J.C.H. Steele,* Clinics in laboratory medicine, Emerging Infections and their causative agents. vol 24,issue 3, September (2004) 5. Ananthnarayan & Paniker, Textbook of Microbiology, 8th edition (2009) 6. Godkar Praful, Medical laboratory technology, 2nd edition. (2006) 7. W. Ahrens, I. Pigeot, Handbook of Epidemiology- W. Ahrens, I. Pigeot Springer- Verlag Berlin Herdelberg (2005). 8. Robert H Friis & Thomas A. Sellers, Epidemiology for Public Health Practice-

3rd edition-Jones & Bartlett publishers.(2003)
9. Park & Park, Textbook of preventive and Community medicine, 3rd Edition (2011)
10. Nikuchia Nikanath, Infectious disease surveillance, a Blackwell Publishing, 2005.
11. Richard Dicker, Principles of epidemiology in public health practices 3rd edition, (2006)
12. Riott I.M., Essentials of immunology, Ej.BS. Blackwell Scientific Publishers, London 12th edition(1998)
13. Kuby J., Immunology, W.H. Freeman and co. New york, 2nd edition (1994).
14. Claus D. Elgert, Immunology – Understanding of immune Systerm by Wiley- Liss New York, (1996)
15. William Paul, Fundamentals of Immunology, 5th edition, (2003)
16. Immunology – Essential and Fundamental, Sulabha Pathak and Urmi Palan. 3rd edition, (2011)
17. Kuby, Immunology- 6th edition W. H. Freeman and company- New York.(2007)
18. Fahim Halim Khan, The Elements of immunology- - Pearson Education, 1st Edition (2009)
19. Ian R. Tizard-Thomson Immunology an introduction- 4th edition-, 8th edition, (2008)
20. Travers. GS., Immunobiology –the immune system in health and disease 6th ed, (2005)
21. Caldwell D.R, Microbial physiology & metabolism by 5th edition, Brown publishers(1990)
22. W. V. Shimkots, Moat A.G. & Foster J.W, Microbial physiology, 3rd edition, Wiley,(1999)
23. Brun. W. V. Shimkots I.J, Prokaryotic Development, ASM. Press, (2000)
24. A.H. Rose, Advances in Microbial physiology, Vol. 17, Academic Press, New York (1978).
25. P. M. Rhodes and P. F. Stanbury, Applied Microbial physiology, IRL Press, (1997)
26. I.C. Gunsalus & Rogery Stainer, The Bacteria. Volume I, by Academic press (1960)
27. Albert, Johnson, Lewis, Raff, Roberts & Walter, Molecular Biology of The Cell, 4th edition, (2002)
28. Lodish , Birk, and Zipursky. Freeman, Molecular Cell Biology, 4th edition, New York, (2000)
29. Lipowsky and Sackmann, The Structure and Dynamics of Cell Membrane, 1st edition, Elsevier, (1995)

Cell Movements : from Molecules to Motility- Bray Garland Pub. New York, (2001)

Course VI: **1006 : Microbial Biotechnology & Genetics Practical**

The course is divided into 4 modules of **one credit each** with 15 instructional hrs/module

Objectives: Bioenergetics and molecular Enzymology is an important area of Microbiology. Thorough knowledge of this area is essential for the following reasons:

1. To describe and estimate various catabolic pathways of Carbohydrates, proteins and enzymes.
2. To understand the endogenous metabolism and to list pathways of degradation of organic compounds by bacterial fermentations.
3. To study different properties of enzymes.
4. To conduct experiments in Enzyme catalysed kinetic reactions.
5. To describe and to relate the expression and regulation of genes.
6. To illustrate Cytoplasmic inheritance and Chromosomal Rearrangements.
7. To understand and outline the mechanisms of Viral Genetics and developmental Genetics.

The knowledge of these techniques would make students confident while working with R & D, Quality Control, genomics, Molecular biology, Bioprocess Engineering and industrial microbiology departments of industry.

		1 credit
Contents	**Experiments**	Hrs
	Some of the following experiments/assignments will be conducted: 1. Isolation & Identification of Reserve food material Glycigen/Polyphosphatase, PHB) of *B.megaterium* & Azotobacter Sp. 2. Quantitative estimation of amino acides by Rosen method. 3. Quantitative estimation of sugars by summers's method. 4. Demonstration of endogenous metabolism in *B.megaterium* or *E.coli*. & their survival under starvation condition. 5. Quantitative estimation of proteins by Folin-Lowery/Biuret method. 6. Production of fungal alpha amylase using solid-state fermentation/production of proteases by bacterial species & confirmation by determining the achromic point. 7. Purification of fungal alpha amylase or bacterial proteases by fractionation, chromatographic techniques & electrophoretic separation. 8. Studies on enzyme kinetics of alpha amylase/Protease (Optimization of parameters viz, Substrate, enzyme-concentration, reaction pH, Km, Vmax & metal ions as activators & inhibitors. 9. Transformation 10. Conjugation, zygotic induction 11. Transduction 12. Identification of phage nucleic acid 13. Curing of plasmids 14. Study of transposable elements 15. Isolation of host range mutants 16. Problems on gene transfer mechanisms	

	17. Problems on viral genetics 18. Cancer genetics- visit to cancer research centre (such as ACTREC) 19. β galactosidase assay 20. UV mutagenesis 21. Acridine orange mutagenesis 22. Isolation of mutants by Replica plate technique 23. Penicillin enrichment technique 24. Ames test 25. Southern hybridization technique [Demonstration] 26. Northern Blotting technique [Demonstration] 27. Restriction mapping 28. Design of primer & PCR 29. Protein electrophoresis 30. Problems on population genetics	

Reference books	1. Trevor Palmer, Understanding enzymes, 4th edition, Prentice Hall Publishers,(1995) 2. Paul Engel, Enzyme kinetics, John Wiley & Sons, Inc. New York (1977) 3. Dixon & Webb, Enzymes, 3rd Edition, Academic Press, New York, (1979) 4. Lubert Stryer, Biochemistry, 5th edition, WH Freeman, (2002) 5. T. S. Work and E. Work, Laboratory techniques in Biochemistry & Molecular Biology, Part2, (1976) 6. Athel Cormish, Principles of Enzyme Kinetics, Bowden. Butterwoth & Co. (1976) 7. G R Chatwal, Biochemistry, 5th edition, Himalaya Publishing House, (2012) 8. Reginald H Garret, Biochemistry, 4th edition, (2010) 9. Donald Voet, Judith G. Voet, Biochemistry, 4th edition, Wiley, (2010) 10. Russell Doolittle, Methods in Enzymology, vol. 266, (1997) 11. David Glick, Methods of Biochemistry Analysis, Vol. 25, John Willey & Sons, New York, (1979) 12. Benjamin Pierce, Genetics: A Conceptual Approach, 3rd Edition by W. H. Freeman (2008) 13. R. F. Weaver, Gene X – Lewin Molecular Biology, 5th edition, McGraw-Hill. (2012) 14. D. Peter Snustad & Michael J. Simmons, Principles of Genetics, 3rd edition, Wiley, (2002) 15. Nancy Trun and Janine Trempy, Fundamental Bacterial Genetics, Chapters 8,10 and 11, Blackwell Science, 2004 16. William S. Klug & Michael R.Cummings, Concept of Genetics, eleventh edition, (2014) 17. J.D. Watson, Recombinant DNA, 2nd edition, W. H. Freeman, (1993) 18. Watson, Molecular biology of the gene 6th edition, (2007)