

SHRI GURU RAM RAI UNIVERSITY

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017)



Syllabus of M.Sc. Biotechnology Effective from Academic Session 2017-2018

FINAL COURSE STRUCTURE- TOTAL CREDITS 86
(SEMESTER SYSTEM)

Course Code	Semester I	L T P	Credits
MBTC 101	Cell Biology, Developmental Biology & Biophysics	4 0 0	4
MBTC 102	Biological & Radiotracer Techniques	4 0 0	4
MBTC 103	Molecular Biology & Genetics	4 0 0	4
MBTC 104	Biochemistry	4 0 0	4
MBTL 105	Lab Course based on course C 101 & C 102	0 0 3	3
MBTL 106	Lab Course based on course C 103 & C 104	0 0 3	3
	Core credits 22; Total Credits=22		22

Course Code	Semester II	L T P	Credits
MBTC 201	Immunology	4 0 0	4
MBTC 202	Microbiology & Microbial Genetics	4 0 0	4
MBTC 203	Molecular Endocrinology & Enzymology	4 0 0	4
MBTC 204	Biomaths, Biostats, Computers Programming & applications	4 0 0	4
MBTL 205	Lab Course based on course C 201 & C 202	0 0 3	3
MBTL 206	Lab Course based on course C 203 & C 204	0 0 3	3
	Core credits 22; Total Credits=22		22

Course Code	Semester III	L T P	Credits
MBTC 301	Recombinant DNA Technology & Genomics	4 0 0	4
MBTC 302	Bioinformatics, Legal Biotechnology & Bio Business Management	4 0 0	4
MBTL 303	Lab Course based on course C 301 & C 302	0 0 3	3
MBTE 304	Food and Beverages Biotechnology	4 0 0	4
MBTE 305	Research Methodology: Tools & Techniques	4 0 0	4
MBTE 306	Chemical Sciences & Biomaterials	4 0 0	4
MBTE 307	Pharmaceutical Biotechnology & Drug Designing	4 0 0	4
MBTE 308	Plant Biotechnology	4 0 0	4
MBTE 309	Advanced Bioinformatics	4 0 0	4
MBTL 310	Lab Course based on course E 304/305/306 (Any one) & E 307/308/309 (Any one)	0 0 3	3
MBTS 311	Bio – Entrepreneurship	0 0 3	3
MBTS 312	IPR, Patenting & Bioethics	0 0 3	3
	Core Credits 11 + Elective Credits 11; Total Credits = 22		

Course Code	Semester IV	L T P	Credits
MBTC 401	Cell & Tissue Culture	4 0 4	4
MBTC 402	Environmental Biotechnology & Bioprocess Engineering	4 0 4	4
MBTL 403	Lab Course based on course C 401 & C 402	0 0 3	3
MBTE 404	Dissertation	0 0 9	9
MBTS 405	Enzyme Technology	0 0 3	3
MBTS 406	Molecular Virology & Infections	0 0 3	3
	Core Credits 11 + Dissertation 09; Total Credits = 20		

**Paper I: MBTC 101. Cell Biology, Developmental Biology
& Biophysics**

No. of Credits = 4

UNIT I

Plasma membrane: Structure, organisation, lipid bilayer, proteins & 0.75 glycoconjugates, liposomes. Function- Ionic transport, types of transport (symport, antiport, active & passive), channel proteins. Intracellular compartmentalization Structure, organization and functions of Nucleus, Mitochondria, lysosome, Golgi body, Chloroplast, Peroxisome, Endoplasmic reticulum (Rough and smooth) Cell motility and shape: Structure and functions, Microfilament, Microtubules and Intermediate filament. 1.0

UNIT II

Protein Sorting, Vesicular traffic in the secretory and endocytic pathway: transport from endoplasmic reticulum through the Golgi network to lysosome, endocytosis, exocytosis, Molecular mechanisms of vesicular transport and the maintenance of compartments diversity. Cell signaling : General principles (Types of signaling). Cell surface receptor mediated signaling (ion channel, G protein and enzyme linked), Target cell adaptation. 0.75

UNIT III

Cell cycle, Molecular events and regulation. Cell division: General strategy and regulation, Molecular mechanism of mitosis and meiosis. Cancer- Biology: Types of cancer, onset of cancer, Proto-oncogenes and tumor suppresser genes, Oncogenic mutations affecting cell proliferation, cell cycle and genome stability. Programmed cell death, Apoptosis. 0.75

UNIT IV

Developmental Biology: Mechanism of fertilization, morphological and molecular aspects: acrosomal reaction, cortical reaction, blocks to polyspermy, parthenogenesis, Cellular mechanism of development: Morphogenetic cellular movements, classes of cell adhesion molecules, intracellular communication. 0.5

UNIT V

Physical phenomena and processes in the living organisms. Principle of measurement. Physical units of measurement, their systems, the SI system. Main types of thermodynamic systems. Laws of thermodynamics. Gaseous, liquid and solid state of the matter, particle interactions as the basis of the states. Waves as a kind of mechanical motion. Characteristic quantities for waves. Doppler effect. Applications of ultrasound in medical diagnostics. Electromagnetic waves, Physical characterization of light. X-rays, their properties. Sources of X-radiation. Applications of X-rays to biology and medicine. Radioactivity and radioactive isotopes. Effect of radioactive radiations onto living organism. 1.0

Recommended Books:

1. Lodish et al.: Molecular Cell Biology (4th ed.)
2. Alberts et al.: Molecular Biology of the cell (3rd ed.)
3. Scott F. Gilbert: Developmental Biology (5th ed.)
4. Zubay, Parson & Vance: Principles of Biochemistry
5. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelplna

Paper II: MBTC 102. Biological & Radiotracer Techniques

No. of Credits = 4

UNIT I

Analytical separation methods : 1.0
 Chromatography - General principle and application
 Adsorption chromatography, Partition chromatography, Gas chromatography, liquid chromatography, Paper chromatography, Thin layer chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, HPLC (High Performance/Pressure Liquid chromatography).

UNIT II

Electrophoresis - General principle and application 0.75
 Paper electrophoresis, Moving boundary method, Gel electrophoresis (Native, Denaturing & Reducing), Disc Gel electrophoresis, Slab Gel electrophoresis, Isoelectrofocussing (IEF), Isotachophoresis

UNIT III

Centrifugation: Basic principles. Common centrifuges used in laboratory 0.75
 (clinical, high speed & ultra centrifuges). Sedimentation rate, Sedimentation coefficient, Zonal centrifugation, Equilibrium density gradient centrifugation
 Types of rotors (fixed angle, swing bucket),
 Types of centrifugation: Preparative, differential & density gradient

UNIT IV

Basic knowledge of the principles and applications of Microscopy: 0.5
 Light, phase contrast, Fluorescence and Confocal microscopy, Scanning and Transmission Electron microscopy.
 Biosensors: Introduction & principles. First, second & third generation instruments, cell based biosensors, enzyme immunosensors.

UNIT V

Spectroscopic methods: principle and applications of UV-visible, IR, NMR, ESR 1.0
 Spectroscopy. Principle & application of X-ray crystallography.
 Application of radioisotopes in biology. Properties and units of radioactivity.
 Radioactive isotopes and half life.
 Measurement of radioactivity: GM Counter, gamma counter, liquid scintillation counter.
 Tracer techniques of Autoradiography, Radioimmunoassay.
 Safety rules in handling of radioisotopes and hazardous chemicals.

Recommended Books:

1. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991.
2. Alberts et al.: Molecular Biology of the cell (2nd ed.), Garland, 1989.
3. Biochemical Technique: Theory & Practical J.F. Robyt & B.J. White \$ 30.95. Waveland Press, Inc.
4. Wilson & Walker: Practical Biochemistry (4th ed) University of Hertfordshire Cambridge University Press
5. Jayraman: Laboratory Manual in Biochemistry
6. Arnold L. Demain & Julian E. Davies: Manual of Industrial Microbio. & Biotech. 2nd ed.

Paper III: MBTC 103. Molecular Biology & Genetics

No. of Credits = 4

UNIT I

Chemical and physical properties of nucleic acids 0.75
 Structure and types of RNA and DNA,
 The Watson-Crick model.
 DNA as genetic material. Different forms of DNA.
 Topological properties of DNA.
 DNA renaturation kinetics.

UNIT II

Mechanism of DNA replication in prokaryotes and eukaryotes. 1.0
 Mechanism of transcription in prokaryotes and eukaryotes.
 Reverse transcription.
 Post transcriptional processing of RNA: (capping, polyadenylation, splicing, RNA editing)
 Mechanism of translation in prokaryotes and eukaryotes.

UNIT III

Concept of genetic code, Gene expression and regulation in prokaryotes (Lac operon 0.75
 and tryptophan operon)
 Gene expression and regulation in eukaryotes.
 Introduction to various types of DNA damage and repair.
 Retrovirus and cancer.

UNIT IV

Mendelism: The basic principles and applications of inheritance, exceptions to mendelian law. 1.0
 The chromosomal basis of Mendelism (chromosomal theory of heredity)
 The molecular structure of chromosome in eukaryotes: structure of chromatin and
 Higher order packaging in chromosome. Centromere and telomere,
 Giant chromosome : polytene and lampbrush chromosome.
 Linkage, Recombination and chromosome mapping in eukaryotes.
 Cytoplasmic inheritance.

UNIT V

Chromosomal Aberrations: Change in Number and Structure 0.5
 Allelic variation and Gene function.
 Sex chromosome and sex determination.
 Dosage compensation of X-linked gene.
 Sex linked gene in human.
 Pedigree analysis in man.

Recommended Books:

1. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
2. Straehan & Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.
3. Snustad et al: Principles of Genetics 1997, John Wiley & Sons,
4. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelplna
5. Strickberger: Genetics, 1996, Prentice Hall
6. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House,
7. Alberts et al: Molecular biology of the cell (4th ed.) 1994, Garland Publ. New York.
8. Elliott & Elliott: Biochemistry and Molecular Biology, 1996, Oxford

Paper IV: MBTC 104. Biochemistry

No. of Credits = 4

UNIT I

Enzymes: Classification (rationale, overview and specific example) 0.75
 Zymogens and their activation (protease and Prothrombin)
 Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Lock and Key Hypothesis, Induced –Fit Hypothesis, Michaelis-Menten equation and its derivation,
 Different plots for the determination of Km and Vmax . Enzyme inhibition: types of inhibition, determination of Ki, suicide Inhibitor.

UNIT II

Carbohydrate – Classification, structure and functions 1.0
 Carbohydrate Metabolism I: Pathway and regulation of Glycolysis, Gluconeogenesis, Glycogenolysis, Glycogenesis
 Carbohydrate Metabolism II: Citric acid cycle and its regulation, electron transport chain and oxidative phosphorylation, pentose phosphate pathway and its regulation.

UNIT III

Protein – Classification, structure and functions 0.75
 Amino Acid Metabolism: Overview of Amino acid degradation,
 Urea cycle (conversion of ammonia into urea, linkage between urea cycle and citric acid cycle) and its regulation.
 Conversion of nitrogen to ammonia by microorganisms, overview of amino-acid biosynthesis. Overview of N₂ fixation

UNIT IV

Fatty Acids - Classification and structure 1.0
 Fatty Acid Metabolism: Fatty Acid Oxidation and regulation β -oxidation, Oxidation of unsaturated fatty acids and odd chain fatty acids. β -oxidation in peroxisomes, ketone bodies and their overproduction.
 Fatty Acid Biosynthesis and Regulation. Reactions of fatty acid synthase, synthesis of triglycerols, membrane phospholipids & prostaglandins.
 Cholesterol biosynthesis and regulation.

UNIT V

Nucleic Acid - structure and functions 0.5
 Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation. Formation of deoxyribonucleotides. Salvage pathway for purine & pyrimidine in nucleotides, Degradation of purines and pyrimidines into uric acid and urea.
 Integration of Metabolism.

Recommended Books:

1. Lehninger: Principles of Biochemistry, 4th ed., Nelson & Cox, WH Freeman and Company, 2007
2. Voet & Voet: Biochemistry, 2nd ed., Wiley & Sons.
3. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
4. Garrett & Grisham: Biochemistry, 4th ed., Brooks/Cole Cengage Learning, 2010.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27th ed. McGraw Hill, 2006.
6. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Willey India, 2007.

Paper VII: MBTC 201. Immunology

No. of Credits = 4

UNIT I

Overview of The Immune System Cells and Organs of The Immune System Antigens, Antigenicity versus Immunogenicity Haptens & Epitopes	1.0
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UNIT II

Immunoglobulins: Structure and Function Major Histocompatibility Complex Antigen processing and presentation Structure and functions of BCR & TCR	1.0
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UNIT III

Cytokines The Complement System Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis Ab-dependent cell mediated cytotoxicity (ADCC)	0.75
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UNIT IV

Overview of Hypersensitivity and Autoimmunity Introduction to Transplantation Vaccines: Active and Passive Immunization	0.5
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UNIT V

Introduction to Monoclonal Antibodies and Hybridoma technology Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.	0.75
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Recommended Books:

1. Kuby : Immunology (4th ed.)
2. Roitt, Male & Brostoff : Immunology (3rd ed).
3. Elgert & Elgert : Immunology
4. Wilson & Walker: Practical Biochemistry (4th ed.)

Paper VIII: MBTC 202. Microbiology & Microbial Genetics

No. of Credits = 4

UNIT I

Classification of living organisms and general account of microorganisms: Bacteria, Fungi and Viruses. 0.75

Introduction to bacteriology: Fine structure of bacteria; Laboratory identification and staining techniques.

UNIT II

Media for microbial culture, selective Differential media and Enriched media; Pure culture techniques, Sterilization techniques. 0.75

Introduction to virology: classification, general structure and reproduction of viruses. Cultivation of bacteriophages, Plant Viruses, Animal Viruses.

UNIT III

Microbial growth: Synchronous & Diauxic, Factors affecting Microbial growth, Measurement of microbial growth (cell number & cell count). 1.0

Modes of nutrition: Photoautotrophs, photoorganotrophs, chemolithotrophs, Chemoorganotrophs.

Microbial metabolism: Overview of Energy production and utilization, N₂ fixation.

UNIT IV

Modes of Genetic Recombination in Bacteria: Conjugation – F-factor, conjugal transfer process, high frequency recombination (hfr) strains. 1.0

Transformation – competence, DNA uptake by competent cells. Mechanism of transformation.

UNIT V

Transduction – General & specialized transduction. 0.5

Genetics of bacteriophages: Lytic and lysogenic cycle, expression of phage genes in regulation of lytic and lysogenic circuit.

Recommended Books:

1. Tortora, Funke, Case: Microbiology, (9th ed.) Pearson Education, Inc, 2009.
2. Prescott, Harley & Kliens: Microbiology (7th ed.) McGraw-Hill International Edition, 2008.
3. Michael J. Pelczar, E.C.S. Chan, Noel R. Krieg: Microbiology (5th ed.) Tata McGrall-Hill, 2008.
4. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (8th ed.) Jones & Bartlet Publ. 2007.

Paper IX: MBTC 203. Molecular Endocrinology & Enzymology

No. of Credits = 4

UNIT I

Mechanism of hormone action: Signal discrimination, signal transduction and signal amplification. Receptors: identification and physico-chemical properties. Hormone-receptor interaction, binding to cellular receptors. Pineal hormone. Pineal as a photo-transducer. Biosynthesis, secretion and physiological actions of protein hormones. 1.0

UNIT II

Biosynthesis, control of secretion & physiological actions of amino acid derived hormones (Thyroid). Environmental Iodine deficiency disorders and thyroid. Pancreatic hormones. Hormonal regulation of carbohydrate, lipid, protein and nucleic acid metabolism 1.0
Biosynthesis of steroid hormones: Steroidogenesis, cellular sites of synthesis
Physiological actions of estrogen, progesterone.
Hormonal control of Estrus / Menstrual cycle.
Brief introduction to female & male infertility (causes and diagnosis).

UNIT III

Biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions. Stress & Adrenal. 0.75
Phytohormones: Introduction to plant growth regulators. Auxins, Gibberlins, Cytokinins
Ethylene: A volatile hormone, Triacontanol, Brassins, Polyamines and Abscisic acid, its role and function.
Environment & Hormonal control of flowering in plants.

UNIT IV

Historical perspectives of enzyme 0.5
Isolation, crystallization and purification of enzymes,
Methods of enzyme analysis. Enzyme technology: Methods for large scale production of enzymes. Immobilized and soluble enzymes and their application. Artificial enzyme. Enzyme electrodes, Enzyme reactors.
Two substrate reactions: Random ordered and ping pong mechanism.

UNIT V

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: nucleophilic and covalent. Mechanism of reactions catalyzed by enzymes. Specific examples: chymotrypsin, lysozyme, ribonuclease and carboxypeptidase. Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Concerted and sequential models. Isozymes special reference to lactate dehydrogenase. Ribozymes. 0.75

Recommended Books:

1. Endocrinology, Mac E. Hadley: Prentice-Hall International Sixth ed. 2009.
2. Basic and Clinical Endocrinology, F.S. Greenspan & P.H. Forsham: Maruzen Asian Ed. Lange Medical Publ. USA, Singapore
3. Williams Textbook of Endocrinology, Wilson Foster, VII Ed..Saunders Inter. ed. London, 1985.
4. Essential Endocrinology John F. Laycock Peter H. Wise:
5. Lodish et al. Molecular Cell Biology
6. Ross & Stanbury: Plant Physiology

Paper X: MBTC 204. Biomaths, Biostats, Computers Programming applications

No. of Credits = 4

UNIT I

1.0

Relation of Life Science with mathematics, Linear function concept, 0.5 coordinate system, trigonometry relations, differentiation & integration concept, logarithms, complex numbers, Plotting of graphs, matrices.

UNIT II

1.0

Importance of statistics in biomedical research.
Mean, Mode, median, range, mean deviation, standard deviation, standard error, skewness & kurtosis
Correlation & Regression
Probability: Theorems, Addition rules, multiplication rules, probability applications, probability distributions- Binomial, Poisson & Normal Distributions.

UNIT III

0.75

Chi square test-characteristics of Chi square test, validity of Chi square test, applications of Chi square test
Test for significance- comparison of means of two samples, comparison of means of three or more samples(f-test, t-test)

UNIT IV

0.75

Introduction to algorithm, flowchart, problem solving methods, need for computer language, reading C Programs, C Character sets, identifier & keywords, data types, constants & variables, pre-processor directives, operators & expressions, control statements, for, while, do-while loops, if-else, switch, break, continue & goto statements.

UNIT V

0.5

Introduction to Computers: Mini, micro, mainframe and super computers.
Components of a computer system (CPU, I/O units).
Data storage device, Memory concepts. Software and types of software.
Elementary idea of Disk operating system (DOS). Elementary ideas of applications of common packages, WINDOWS (95, 98). Computer applications in biology and information communications (databases, e-mail and local networks).
Applications of common packages, Microsoft Office: Microsoft word, Microsoft excel, Microsoft PowerPoint.

Recommended Books:

1. Rajaraman V: Computer Programming in "C". PHI.
2. Yashwant Kanetker: Let us "C" BPB.
3. Peter Norton's: Introduction to Computer.
4. Hoel, P.G: Elementary Statistics John Wiley & Sons, Inc. New York.
5. Mahajan: Methods in Biostatistics (4th ed.) Jaypee Bros. 1984.
6. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 1993.
7. D. Rajaraman & V. Rajaraman: Computer primer (2nd ed.) Prentice Hall of India, New Delhi.
8. Roger Hunt & John Shelley: Computer and Commonsense Prentice Hall of India, New Delhi.
9. Norton, Peter: Introduction to Computers (2nd ed.), TMH Publishing Company Ltd., New Delhi.

**Paper XIII: MBTC 301. Recombinant DNA Technology
& Genomics**

No. of Credits = 4

UNIT I

Introduction to Recombinant DNA technology and applications. 1.0
Cloning vector: Plasmids, Phages, cosmids,
Yeast cloning vectors, Animal and plant viruses as vectors.
BAC, PAC & YAC.
Nucleic acid modifying enzymes. Restriction endonuclease
Isolation of nucleic acid from plant, animal & bacteria.

UNIT II

Basic steps of gene cloning: Cloning strategies. 1.0
Synthesis of cDNA. Construction of cDNA and genomic libraries.
Selection of r DNA clones and their expression products, chromosome walking.
Expression of cloned genes in heterologous host.
Probe labeling and hybridization.
Blotting techniques: Southern, Northern and
Western blotting (Methodologies and applications)

UNIT III

DNA sequencing: chemical and enzymatic methods. 0.75
PCR. Site directed mutagenesis.
Ribonuclease protection assay, Gel retardation assay,
DNA foot printing, DNA finger printing, DNA profiling.

UNIT IV

Genomic analysis: Exon-intron trapping, S-1 mapping, RFLP, RAPD, AFLP. 0.75
Transgenic Technology:
Types approaches & application (Plant & Animals)

UNIT V

Gene therapy: Principles, strategies and ethics of gene therapy. 0.5
Genomics: Structural, Functional and Comparative.
Expressed Tag sequence.
Human Genome Project-Strategy and implications.

Recommended Books:

1. Gene cloning T.A Brown:
2. Molecular Biotechnology, Glick & Pasternak: Panima Publ. Corporation, 1994
3. Molecular biology & Biotechnology (3rd ed), Walker & Gingold: Panima Publ. Corporation, 1999
4. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
5. Straehan & Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.
6. Gene cloning, Glover: 1984
7. Recombinant DNA, Watson et al: 1983
8. Genetic Engineering Vol. 1-4, Villiamson (ed)
9. Genetic Engineering Vol. 1-7 Setton and Bolanden (ed)

Paper XIV: MBTC 302. Bioinformatics, Legal Biotechnology & Bio Business Management

No. of Credits = 4

UNIT I

Introduction to bioinformatics. Objectives, Application and Scopes, 0.75
IT in biology, bioinformatics resources on NET, Internet, World wide web, Web Browsers.
Biological databases-Primary, secondary database, Bibliographics, GEN BANK,
EMBL, DDBJ, SWISSPROT. Search engine-Entrez, SRS Web Server-NCBI, EBI

UNIT II

Sequence alignment and applications: Local and Global alignment; 0.75
Scoring Matrices; Homology and related concepts; Dot matrix; general gap, gap penalty
Dynamic Programming methods for global and local alignments; sequence similarity
searching tools – FASTA, BLAST; Statistical and biological significance.
Multiple Sequence alignment and applications.

UNIT III

Legal and IPR issues in Biotechnology, Intellectual Property Protection (IPP), 0.75
Trade secret protection, licensing of bio-product, procedure for obtaining patent,
characteristics of the disclosure for a biotechnology invention, marketing a
biotechnology invention, trade regulations.

UNIT IV

Worldwide market scenario of biotechnology based business, 1.0
Biobusiness prospective in India. Management Process & organization,
General analysis of Indian Biobusiness, Project formulation and selection based on
size, technological assessment, technical report, feasibility and
commercial viability of project.

UNIT V

Total product cost, capital investment and profitability, 0.75
manufacturing and cost estimation for biological products for R & D decision making.
Marketing management and consumer behavior, Marketing of
pharmaceuticals and other bioproducts.

Recommended Books:

1. Lesk: Introduction to Bioinformatics, Wiley Publication.
2. Primrose and Twyman: Principles of genomes and genomics.
3. ROM and Holmas EC: Molecular Evolution: a phylogenetic approach, Blackwell science.
4. Des Higgins and Willie Taylor: Bioinformatics: Sequences, structure and databanks, Oxford University Press
5. P. Narayan: Patent Law.
6. S. L Rao: Economic reforms and Indian markets.
7. Sharma, Munjal, Shankar: A Text Book of Bioinformatics, Rastogi Publication
8. Bioinformatics: Methods and Applications Genomics Proteomics and Drug Discovery, S C Rastogi, N Mendiratta, P. Rastogi: Prentice Hall of India Private Ltd
9. Manual of Industrial Microbiology and Biotechnology by A. L. Demain and N.A. Solomon.

MBTE 304: Food and Beverages Biotechnology

No. of Credits = 4

UNIT I

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes 0.75

UNIT II

Contamination and spoilage of different kinds of food & beverages: Cereals & cereal products, sugar and sugar products, vegetables and fruits, meat, fish, poultry & eggs, sea food, milk & milk products, canned foods, Alcohol & alcoholic beverages fruit juices & soft drinks etc. 0.75

UNIT III

Biotechnology of food and feed; cultures & fermentation, Beverage production: Alcohol & alcoholic beverages, fruit juices, soft drinks, feed production, SCP, fats, amino acid, food additives. 0.75

UNIT IV

Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication. Food-borne disease outbreaks, Disease-investigation, Materials & Equipments, laboratory testing, field analysis, interpretation of data and preventive measures. 0.75

UNIT V

Food hygiene: Food sanitation, Bacteriology of water and food products, food manufacturing practice. Hazard Analysis Critical Points. Food control: International agencies, Federal Agency and law of state agencies, Processing Industry and Microbial criteria of food. Principles of food preservation Preservation by high temperature, low temperatures, Drying, Food additives and Radiation. 1.0

Recommended Books:

1. Food Biotechnology. S.Bielecki, et al - (Ed) Elsevier Science (2000)
2. Food Biotechnology. Kalidas Shetty et al – CRC Press (2005)

MBTE 305: Research Methodology: Tools & Techniques

No. of Credits = 4

UNIT I

Importance and need of scientific research. 0.75
Problem identification, objectives, significance, scope and limitations.
Literature survey: Use of books, journals, libraries, online survey.
Importance and designing of the problem to be undertaken.

UNIT II

Field survey, Site selection, Source selection for data acquisition. 0.75
Sampling techniques: Simple and random sampling,
Systematic sampling, Stratified sampling, Multistage sampling,
Cluster sampling, Multiphase sampling, Sample size,
Frequency, Bias, Error,

UNIT III

Methods: Data collection, Types of data, Qualitative and quantitative data. 1.0
Primary and secondary data, Data summarization
Data representation: Tabular and diagrammatic representation of data.
Measures of central tendency: Use of mean, mode, median, data interpretation.

UNIT IV

Measures of dispersion: Use of range, variance, standard deviation, standard error. 0.75
Correlation, multiple correlations,
Regression, multiple regressions, standard error of estimate.
Test of significance: t-test, 95% confidence limit,
Chi square test, F-test, Multivariate test.

UNIT V

Project Report: Preparation, introduction of the problem, Materials and methods, 0.75
Review of literature, Results, Discussion (interpretation of results),
Referencing technique, summary of research/abstract etc.
Publication of scientific data, writing research paper & report.

Recommended Books:

1. Holmes, Moody, Dine: Research Methods for the Biosciences, 1st Indian ed., Oxford University Press, 2006.
2. N. Gurumani: Research Methodology for Biological Sciences, 1st ed., MJP Publishers, 2008.
3. Wilson and Walker: Principles & Techniques, 4th ed. Cambridge low price ed., 1995.
4. Schmauder: Methods in Biotechnology, Taylor & Francis Publishers, 2003

MBTE 306: Chemical Sciences & Biomaterials

No. of Credits = 4

UNIT I

Polymer materials: synthesis, characterization (inter polymers, biodegradable polymers, hydro gels, natural polymers, genetically engineered polymers, Bioactive polymers). 0.75

UNIT II

Biocompatibility of biomaterials, protein structure, interaction of proteins with synthetic materials; methods for evaluating protein adsorption. 0.75

UNIT III

Cell: interactions with proteins and materials, characterization of cell material interaction, Blood compatibility: platelets adhesion and aggregation, coagulation effects. 0.75

UNIT IV

The mechanical environment: In vitro assessment of blood compatibility, Interactions of bacteria with biomaterials: methods of sterilization, assessment of sterility. 0.75
Design of biocompatible materials: modification of materials to improve biocompatibility.

UNIT V

Cardio vascular applications: grafts, catheters, stents valves, embolic agents. 1.0
Orthopedic applications: joint prostheses, fracture fixation devices, interaction of bone with implanted materials and resulting complications.
Drug delivery: types of devices, targeting gene therapy, stability of drug in contact with biomaterials.

Recommended Book:

1. Remingtons Pharmaceutical Sciences, 20th editions, Lippincott, William and Wilkins.
2. Ansel's Pharmaceutical Dosage forms and drug Delivery System 8th edition by Loyd V, Allen, Nicholas G., Popovich, Howardc. Ansel, Publisher Lippincott, Williams and wilkins.
3. Remingtons: The science and practice of Pharmacy.
4. An Introduction to Biocomposites Vol 1 (2004) by Seeram Ramakrishna et al World Scientific Publishing Compan

MBTE 307: Pharmaceutical Biotechnology & Drug Designing

No. of Credits = 4

UNIT I

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization. 0.75

UNIT II

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. 0.75
Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.

UNIT III

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotypic vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems. 0.75

UNIT IV

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation. 0.75

UNIT V

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. 1.0
Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.

MBTE 308: Plant Biotechnology

No. of Credits = 4

UNIT I

Clonal propagation/micropropagation and its applications to horticulture and forestry. 0.75
Production of disease free plants.
Incompatibility in plants. Methods to overcome incompatibility.

UNIT II

Somatic embryogenesis and production of synthetic seeds . 0.75
Selection of stress tolerant cell lines, resistance to cold,
high temperature, salt, drought, diseases and inhibitors.
Conservation of plant genetic resources in vitro, its applications and limitations.

UNIT III

Application of Plant Transformation for productivity and performance: 1.0
herbicide resistance, insect resistance, Bt genes, non-Bt like protease inhibitors,
alpha amylase inhibitor, disease resistance, nematode resistance,
post harvest losses, long shelf life of fruits and flowers, male sterile lines,
bar and barnase systems, carbohydrate composition and storage.

UNIT IV

Metabolic Engineering and Industrial Products: plant secondary metabolites, 1.0
control mechanisms and manipulation of phenylpropanoid pathway,
shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics,
therapeutic proteins.

UNIT V

Biofertilisers, production of vaccines in plants, trade and potentials, 0.5
Ecological Risks of transgenic crops and global market.
Biodiversity and its conservation, germplasm collection.
Restoration of degraded lands, Nursery technology, Green house technology.

Recommended Books:

1. P.K. Gupta: Elements of Biotechnology, Rastogi and Co. Meerut, 1996
2. R.J. Hanry: Practical Application of Plants Molecular Biology, Champan and Hall, 1997
3. H.D. Kumar: Modern Concepts of Biotechnology, Vikas Publ. Pvt. Ltd.
4. B.D. Singh: Biotechnology, Kalyani Publ.

MBTE 309: Advanced Bioinformatics

No. of Credits = 4

UNIT I

Introduction to Bioinformatics: Definition and History of Bioinformatics, Introduction to internet, Bibliographic and non bibliographic search, PubMed Introduction to various biological databases (primary, secondary and composite databases). Introduction to biological information system: SRS, ENTREZ (Structure and use on web). 0.75

UNIT II

Introduction to Data mining: Classification, Clustering, Data collection, Data Warehousing, Data preprocessing, Applications of Data Mining and Genomes mining. Data Bases: Nucleotide sequence information sources: GenBank, EMBL, EBI, DDBJ, UCSC. Protein sequence information sources: PIR, ExPASy, UniProt KB, SwissProt, TrEMBL, Protein structure information sources: PDB, SCOP, CATH, HSSP. 1.0

UNIT III

Biocomputing : Introduction to String Matching Algorithms, Database Search Techniques, Sequence Comparison and Alignment Techniques, Use of Biochemical Scoring Matrices, Introduction to Graph Matching Algorithms, Automated Genome Comparison and its Implication, Automated Gene Prediction, Gene Arrays, Analysis of Gene Arrays. Introduction to Signaling Pathways and Pathway Regulation (KEGG), Systems Biology-an introduction 0.75

UNIT IV

Genoinformatics
Genome Annotation:- Introduction, ORF's. 0.75
Gene mapping and applications: Genetic and Physical Mapping, Transcriptome and Proteome- General Account
Sequence Alignment: Pairwise and multiple alignment, Dynamic programming.
Soft wares (SSearch, BLAST, FASTA, CLUSTAL W), Phylogenetic analysis: phenetic and cladistic approach. Phylogenetic Tree Construction (rooted and unrooted method), Completed Genomes: Bacterium, Nematode, Plant and Human

UNIT V

Production of Protein Structure & Modeling 0.75
Protein Primary & Secondary Structure, Prediction Methods – Introduction to various methods. Tertiary structure prediction (Homology & Threading Methods) Profiles, Motifs – Regular Expressions. Repeat Finding and pattern Recognition Molecular modeling, Docking and Rational Drug design.

Recommended Books:

1. Moorhouse & Barry: Bioinformatics, Biocomputing and Perl (Wiley-liss publications).
2. Jones & Prvzner: Introduction to Bioinformatics Algorithm, Anne Press.
3. Pevsner: Bioinformatics & Functional Genomics, Wiley-publication.
4. Zimmerman: Introduction to Protein Information.
5. Bourne & Weissig: Structural Bioinformatics, Wiley-Liss Publication.
6. Gustafson, Shoemaker, Snape: Genome Data Mining Exploitation: the Genome.
7. Richard S Larson: Bioinformatics and drug discovery, humana press.
8. Sharma, Munjal & Shankar: A Text Book of Bioinformatics, Rastogi Publication

MBTS 311: Bio – Entrepreneurship

No. of Credits = 3

Unit I

Starting a venture; Assessment of feasibility of a given venture/ new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/ Plan for seeking loans from financial institution & Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; 0.5

Unit II

Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping. Estimation of income, expenditure, profit. Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/Advertising. 0.75

Unit III

Services Marketing Negotiations/Strategy with financiers, bankers, Government/ law enforcement authorities; with companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/Avoiding/Managing. Information Technology: How to use IT for business administration; Use of IT in Improving business performance; Available software for better financial management; E-business setup, management. 0.75

Unit IV

Human Resource Development (HRD): Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up. Fundamentals of Entrepreneurship, Support mechanism for entrepreneurship in India 0.5

Unit V

Role of knowledge centre and R&D. Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies. Case Study: 0.5

Recommended Books:

1. Handbook of Bioentrepreneurship Vol 4. by Holger Patzelt & Thomas Brenner (ed) Springer(2008)
2. Handbook of Entrepreneurship Research, 2005. Zoltan J. Acs and David B. Audretsch (eds.)
3. Handbook of Entrepreneurship Research: Interdisciplinary Perspectives, 2005. Sharon A. Alvarez, Rajshree Agarwal, and Olav Sorenson (eds.):
4. The Life Cycle of Entrepreneurship Ventures, 2005.Simon Parker (ed.)
5. Handbook of Bioentrepreneurship, Holger Patzelt and Thomas Brenner (eds.)

MBTS 312: IPR, Patenting and Bioethics

No. of Credits = 3

Unit I

Introduction to Intellectual Property: 0.5
 Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs
 IP as a factor in R&D; IPs of relevance to Biotechnology and few

Unit II

Agreements and Treaties: 0.5
 History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit III

Patents: 0.75
 Basics of Patents and Concept of Prior Art. Introduction to Patents:
 Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees
 Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.)

Unit IV

Patent filing procedures 0.5
 National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes
 Patent licensing and agreement
 Patent infringement- meaning, scope, litigation, case studies

Unit V

Introduction to Bioethics. Social and ethical issues in Biotechnology, causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains. Professional ethics - professional conduct, Ethical decision making, ethical dilemmas, good laboratory practices, good manufacturing practices, laboratory accreditation 0.75

Recommended Books:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007

Important Links:

<http://www.w3.org/IPR/>
<http://www.wipo.int/portal/index.html.en>
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
<http://www.patentoffice.nic.in>
<http://www.iprlawindia.org/> - 31k - Cached - Similar page
<http://www.cbd.int/biosafety/background.shtml>
<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>
<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

Paper XX: MBTC 401. Cell & Tissue Culture

No. of Credits = 4

UNIT I

Tissue & Cell Culture: Objectives & goals. Structure & organization of animal and plant cell. Equipments and materials for culture technologies & Aseptic techniques. Safety: Risk assessment, general safety. 0.75

UNIT II

Animal cell culture medium: BSS & simple growth medium. Serum free media, Role of CO₂ serum & supplements. Primary cell culture & cell lines, Cell separation, Biology & characterization of cultured cells. *In vitro* mammalian cell culture, Disaggregation of tissue and primary culture, maintenance of cell culture, Scaling-up of animal cell culture, cell synchronization. 0.75

UNIT III

Cell cloning & cell transformation. 0.5
Application of animal cell culture: stem cell culture, Embryonic stem cells, cell cultured based vaccines. Specialized cell.

UNIT IV

Introduction to plant cell & tissue culture, Plant tissue culture media-composition & preparation. 1.0
Micro propagation, Callus culture, suspension culture, organogenesis. Meristem culture. Haploid culture: Androgenesis & Gynogenesis. Embryo culture & Embryo rescue, Protoplast culture & protoplast fusion – Cybrids, Symmetric & Asymmetric hybrid. Somatic embryogenesis and Somaclonal variation, cryo-preservation.

UNIT V

Ti & Ri plasmids, Binary vector, expression vector, cointegrated vector. 1.0
Transformation: Vector mediated and vector less DNA transfer (Particle bombardment, electroporation, microinjection) in plants. Detection of DNA transfer. Transformation of monocots. Application of plant cell & tissue culture: Transgenics, secondary metabolites, Industrial enzyme, edible vaccine.

Recommended Books:

1. R. Ian Freshney: Culture of Animal Cells (3rd ed.), Wiley-Liss.
2. M. Butler & M. Dawson: Cell Culture Lab Fax. Eds. Bios Scientific Publ. Ltd. Oxford
3. M.K. Razdon; Plant tissue culture, IBH & Oxford publ. Pvt. Ltd.
4. H. S. Chawla: Introduction to Plant biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

M.Sc. Biotech 4th Sem.

**Paper XIX: MBTC 402. Environmental Biotechnology
& Bioprocess Engineering**

No. of Credits = 4

UNIT I

1.0

Environmental Biotechnology: Concept, components of environment Air pollution and its control through Biotechnology (deodorization, reduction in CO₂ emission, bioscrubbers, biobeds, biofilters etc).
Water pollution and its controls: Sources of water pollution, waste water treatment-physical, chemical and biological processes (aerobic & anaerobic processes)
Solid waste: Sources and management (composting, vermiculture and biogas production)

UNIT II

1.0

Xenobiotics in Environment: Xenobiotic compounds, Recalcitrance, Biobleaching and Biomining.
Bioremediation: Types, in situ and ex situ bioremediation; Bioremediation for herbicides, Pesticides, hydrocarbons and oil spills
Hospital wastes, hazardous waste and their management.
Biopesticides in integrated pest management.
Biofertilizers.

UNIT III

0.75

Global Environmental Problems: Ozone depletion, UV-B, green-house effect and acid rain, their impact and biotechnological approaches for management.
Restoration of waste land/degraded ecosystem.
Industrial pollution and its control: Pulp & Paper, Tannery, Dairy and Petroleum.
Basic concepts of Environmental Impact Assessment (EIA)
Environment Management: Concept & Approaches

UNIT IV

1.0

Introduction to fermentation processes and types of fermentation
Microbial Growth Kinetics; Isolation, Preservation and Improvement of industrially important microorganisms
Production of solvents (Ethanol, Butanol), Antibiotics (Penicillin, Tetracycline) and Alcoholic beverages by fermentation.

UNIT V

0.5

Bioreactors: Types and Design; medium rheology
K_{La} measurement and kinetics of media sterilization.
Downstream processing and product recovery.

Recommended Books:

1. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals., Jean R Neeser & J. B German –CRC Press (2004)
2. Environmental Biotechnology, T.R.Srinivas, [1st Ed. ed.] New Age International Pvt Ltd Publishers (2008)
3. Environmental Biotechnology, R.A.Sharma, Pointer Publishers (2007)
4. Environmental Biotechnology (Handbook of Environmental Engineering, Volume 10), Yung-Tse Hung, Lawrence K. Wang, Volodymyr Ivanov, Joo-Hwa Tay, Humana Press. (2010) (1st Ed ed.)

MBTS 405: Enzyme Technology

No. of Credits = 3

Unit-I

0.5

Properties of enzymes : catalytic power, specificity, holoenzymes, apoenzyme, coenzyme and cofactor. Nomenclature and classification of enzymes, active site- Fischer and Koshland models. Collision theory, activation energy and transition state energy, the law of mass action and order reaction.

Unit-II

0.75

Enzyme kinetics: Kinetics of single substrate enzyme catalysed reaction, equilibrium steady state assumption (Michaelis-Menten), transformation of Michaelis Menten equation, Lineweaver Burk, Eadie-Hofstee, Hanes plots. Determination of V_{max}, K_m, K_{cat} and their significance. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Single displacement and Double displacement reaction.

Unit-III

0.5

Enzyme Inhibition: Reversible inhibition- competitive, uncompetitive and non competitive inhibition, allosteric and irreversible inhibitions. Assay of enzymes: Coupled kinetic assay, units of enzyme activity (IU), Turnover number, purification of enzymes and criteria of purity.

Unit-IV

0.75

Enzyme catalysis: Tapping the enzyme substrate complex, use of substrate analogues, enzyme modifications by chemical procedures affecting amino acid chain, treatment with protease, site directed mutagenesis, Factors contributing to the catalytic efficiency-proximity and orientation, covalent catalysis, acid-base catalysis, metal ion catalysis. Mechanisms of enzymes action-lysozyme, chymotrypsin and ribonuclease.

Unit-V

0.5

Vitamin coenzymes: structure and functions, enzyme regulation, feedback inhibition, allosteric kinetics(ATCase), cooperativity, symmetry and sequential models. Isoenzymes (LDH) Multi-enzyme complex (PDH complex), Ribozymes (catalytic RNA) Abzymes (catalytic antibodies), immobilized enzymes and applications.

Recommended Books:

1. Principles of Biochemistry general aspects 1983- Smith et al McGraw Hill.
2. Principles of Biochemistry, 2001, Nelson & Cox, CBS India.
3. Biochemistry, Lehninger, A.H.
4. Text book of Biochemistry, West, E.S., Todd, Manson & Vanbruggen. Macmillan.
5. Organic chemistry, I.L. Finar, ELBS, 1985.
6. Biochemistry, Zubay, C. Addison. Wesley 1986.
7. Biochemistry of Nucleic acids, Adams, E.T. Al. Chapman and Hall, 1986

MBTS 406: Molecular Virology and Infections

No. of Credits = 3

UNIT – I

History of Virology and Biosafety: History and principles of virology, virus taxonomy. 0.75
 Structures of animal and plant viruses and their morphology.
 Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.

UNIT – II

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ , Φ X174, 0.5
 and plant viruses - ss RNA virus (TMV) and ds DNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus and Retro virus.

UNIT – III

Interferon and Antiviral Agents: Viral Interference and Interferons. Nature and source of 0.5
 interferons, Classification of interferons. Induction of interferon.
 Antiviral agents (chemical and biological) and their mode of actions.

UNIT – IV

Cultivation of Viruses and Viral Vaccines : Cultivation of viruses in embryonated egg, 0.5
 tissue culture and laboratory animals. Conventional vaccines - Killed and attenuated.
 Modern vaccines - Recombinant proteins, subunits, DNA vaccines, peptides,
 immunomodulators (cytokines). Vaccine delivery and adjuvants, large-scale manufacturing.

UNIT – V

Virological Methods: Methods for purification of viruses with special emphasis on 0.75
 ultracentrifugation methods. Quantitative diagnostic methods - Haemagglutination,
 complement fixation, neutralization, Western blot, flowcytometry.
 Nucleic acid based diagnosis - PCR, microarray and nucleotide sequencing. Application
 of Microscopic techniques - Fluorescence, confocal and electron microscopic techniques.

Recommended Books:

1. General Virology - Luria and Darnel Virology and Immunology - Jokli
2. Text book of Virology - Rhodes and Van Royen
3. Plant Virology - Smith
4. Genetics of bacteria and their viruses - W. Hayes
5. Molecular Biology of the gene - Watson, Roberts, Staitz and Weiner
6. A laboratory guide in virology - Charles H. Lunningham
7. Basic lab procedures in diagnostic virology - Marty Cristensen
8. Review of medical microbiology - Jawitz et al
9. Medical laboratory Manual for tropical countries Vol I & II by Monica Cheesbrough
10. Text Book of Microbiology - Ananthanarayanan and Jayaram Paniker Viral and Rickettsial
11. Infections of Man - Horsfall and Jam
12. Virological Procedures - Mitchal Hasking Virology - Wilson and Topley
13. Infection and Immunity DH Davies, MA Halablab,, et al (1998) Taylor & Francis Ltd, 1, London
14. Infection and Immunity-Inforna_Healthcare, Jon S. Friedland, Liz Lightstone (2004) Taylor & Francis Ltd, 1, London