

**Department of Zoology & Biotechnology**

# M.Sc. Biotechnology

**Course Contents**

**&**

**Syllabus**



**Hemwati Nandan Bahuguna Garhwal University**

**(A Central University)**

**Srinagar, Garhwal, 246 174, Uttarakhand**

## M.Sc. Biotechnology (July 2013)

| Code   | Course Contents   | L T P C | M.M |
|--|---|---------|-----|
| <b>Semester I (July to November)</b>                             |   |         |     |
| SOLS/BT/C 001  | Cell Biology, Developmental Biology & Biophysics              | 3 0 0 3 | 100 |
| SOLS/BT/C 002  | Biological & Radiotracer Techniques                           | 3 0 0 3 | 100 |
| SOLS/BT/C 003  | Molecular Biology & Genetics                                  | 3 0 0 3 | 100 |
| SOLS/BT/C 004  | Biochemistry  | 3 0 0 3 | 100 |
| SOLS/BT/C 005  | Lab Course based on course C 001 & C 002                      | 0 0 3 3 | 100 |
| SOLS/BT/C 006  | Lab Course based on course C 003 & C 004                      | 0 0 3 3 | 100 |
| <b>Core Credits = 18</b>   |   |         | 600 |
| <b>Semester II (December to April)</b>                           |   |         |     |
| SOLS/BT/C 007  | Immunology  | 3 0 0 3 | 100 |
| SOLS/BT/C 008  | Microbiology & Microbial Genetics                             | 3 0 0 3 | 100 |
| SOLS/BT/C 009  | Molecular Endocrinology & Enzymology                          | 3 0 0 3 | 100 |
| SOLS/BT/C 010  | Biomaths, Biostats, Computers Programming & applications      | 3 0 0 3 | 100 |
| SOLS/BT/C 011  | Lab Course based on course C 007 & C 008                      | 0 0 3 3 | 100 |
| SOLS/BT/C 012  | Lab Course based on course C 009 & C 010                      | 0 0 3 3 | 100 |
| SOLS/BT/SS001  | Epigenetics & Cancer Biology                                  | 0 0 0 3 | 100 |
| SOLS/BT/SS002  | Industrial Microbiology                                       | 0 0 0 3 | 100 |
| <b>Core Credits = 18</b>   |   |         | 600 |
| <b>Semester III (July to November)</b>                           |   |         |     |
| SOLS/BT/C 013  | Bioinformatics, Legal Biotechnology & Bio Business Management | 3 0 0 3 | 100 |
| SOLS/BT/C 014  | Recombinant DNA Technology & Genomics                         | 3 0 0 3 | 100 |
| SOLS/BT/C 015  | Lab Course based on course C 013 & C 014                      | 0 0 3 3 | 100 |
| SOLS/BT/E 001a   | Food and Beverages Biotechnology                              | 3 0 0 3 | 100 |
| SOLS/BT/E 001b   | Research Methodology: Tools & Techniques                      | 3 0 0 3 | 100 |
| SOLS/BT/E 001c   | Chemical Sciences & Biomaterials                              | 3 0 0 3 | 100 |
| SOLS/BT/E 002a   | Pharmaceutical Biotechnology & Drug Designing                 | 3 0 0 3 | 100 |
| SOLS/BT/E 002b   | Plant Biotechnology   | 3 0 0 3 | 100 |
| SOLS/BT/E 002c   | Advanced Bioinformatics                                       | 3 0 0 3 | 100 |
| SOLS/BT/E 003  | Lab Course based on course E 001 & E 002                      | 0 0 3 3 | 100 |
| SOLS/BT/SS003  | Bio – Entrepreneurship  | 0 0 0 3 | 100 |
| SOLS/BT/SS004  | IPR, Patenting & Bioethics                                    | 0 0 0 3 | 100 |
| <b>Core Credits 09 + Elective Credits 09; Total Credits = 18</b> |   |         | 600 |
| <b>Semester IV (December to April)</b>                           |   |         |     |
| SOLS/BT/C 016  | Environmental Biotechnology & Bioprocess Engineering          | 3 0 0 3 | 100 |
| SOLS/BT/C 017  | Cell & Tissue Culture   | 3 0 0 3 | 100 |
| SOLS/BT/C 018  | Lab Course based on course C 016 & C 017                      | 0 0 3 3 | 100 |
| SOLS/BT/E 004a   | Biomedical Technology   | 3 0 0 3 | 100 |
| SOLS/BT/E 004b   | Fish Biotechnology  | 3 0 0 3 | 100 |
| SOLS/BT/E 004c   | Immunotechnology  | 3 0 0 3 | 100 |
| SOLS/BT/E 005  | Dissertation  | 0 0 0 6 | 100 |
| SOLS/BT/SS005  | Enzyme Technology   | 0 0 0 3 | 100 |
| SOLS/BT/SS006  | Molecular Virology & Infections                               | 0 0 0 3 | 100 |
| <b>Core Credits 09 + Elective Credits 09; Total Credits = 18</b> |   |         | 500 |

**Grand Total: Core Credits 54 + Elective Credits 18 = 72 Credits**

**Max. Marks (MM) for each paper: 100 (two Sessional Tests of 20 each + 60 End Term Test)**

**Sessional Tests:-** (Mid Term Test, Assignment, Tutorials, Classroom Seminar & Lab Work, Journal Club, winter/ summer Internship; Industrial/ Institutional visits, training based report writing & presentation)

All 2-year Master's Programmes will have the following components, viz.

- (i) Core Course (C): Minimum 54 Credits
- (ii) Electives (E): Minimum 18 Credits
- (iii) Self study (SS) : Maximum 09 credits (one minimum 03 Credits course shall be mandatory but not to be included while calculating the grades)

M.Sc. 4<sup>th</sup> Semester - Core Courses 3 (2 Theory+ 1 Lab Course of 3 Credits each), Elective Courses 2 (1 Theory of 3 credit + 1 Dissertation of 6 Credits), Dissertation be allotted in the beginning of 3<sup>rd</sup> semester. Dissertation will also be of 6 Credits for the batch 2011-13 & 2012-14

**Paper I: S0LS/BT/C 001. Cell Biology, Developmental Biology  
& Biophysics**

No. of Credits = 3

**UNIT I**

Plasma membrane: Structure, organisation, lipid bilayer, proteins & 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. 0.75

**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. 0.5

**UNIT III**

Cell cycle, Molecular events and regulation. 0.5  
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.

**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  
Mechanism of cellular differentiation: Transcriptional regulation of gene expression during differentiation, transcription factors and the activation of specific promoters, the activation of chromatin.  
Control of development by RNA processing. Translational regulation of developmental processes.

**UNIT V**

Physical phenomena and processes in the living organisms. 0.75  
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.

**Recommended Books:**

1. Lodish et al.: Molecular Cell Biology (4<sup>th</sup> ed.)
2. Alberts et al.: Molecular Biology of the cell (3<sup>rd</sup> ed.)
3. Scott F. Gilbert: Developmental Biology (5<sup>th</sup> ed.)
4. Zubay, Parson & Vance: Principles of Biochemistry

**Paper II: S0LS/BT/C 002. Biological & Radiotracer Techniques**

No. of Credits = 3

**UNIT I**

Analytical separation methods : 0.75  
 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 0.5  
 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 0.5  
 (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 0.75  
 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. 2<sup>nd</sup> ed.

**Paper III: SOLS/BT/C 003. Molecular Biology & Genetics**

No. of Credits = 3

**UNIT I**

Chemical and physical properties of nucleic acids 0.5  
 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. 0.75  
 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 0.5  
 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. 0.75  
 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 Philadelpna
5. Strickberger: Genetics, 1996, Prentice Hall
6. Friefelder: Molecular Biology (2<sup>nd</sup> ed.), 1996 Narosa Publ. House,
7. Alberts et al: Molecular biology of the cell (4<sup>th</sup> ed.) 1994, Garland Publ. New York.
8. Elliott & Elliott: Biochemistry and Molecular Biology, 1996, Oxford

**Paper IV: SOLS/BT/C 004. Biochemistry**

No. of Credits = 3

**UNIT I**

Enzymes: Classification (rationale, overview and specific example) 0.5  
 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 .

**UNIT II**

Carbohydrate – Classification, structure and functions 0.75  
 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 0.5  
 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.

**UNIT IV**

Fatty Acids - Classification and structure 0.75  
 Fatty Acid Metabolism: Fatty Acid Oxidation and regulation  $\beta$ -oxidation, Oxidation of unsaturated fatty acids and odd chain fatty acids.  $\beta$ -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, 4<sup>th</sup> ed., Nelson & Cox, WH Freeman and Company, 2007
2. Voet & Voet: Biochemistry, 2<sup>nd</sup> ed., Wiley & Sons.
3. Berg, Tymoczko, Stryer: Biochemistry, 5<sup>th</sup> ed., WH Freeman and Company, 2003.
4. Garrett & Grisham: Biochemistry, 4<sup>th</sup> ed., Brooks/Cole Cengage learning, 2010.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27<sup>th</sup> ed. McGraw Hill, 2006.
6. Conn & Stumpf: Outlines of Biochemistry, 5<sup>th</sup> ed., Willey India, 2007.

**Paper VII: SOLS/BT/C 007. Immunology**

No. of Credits = 3

**UNIT I**

|  |      |
|--|------|
| Overview of The Immune System                | 0.75 |
| Cells and Organs of The Immune System        |      |
| Antigens, Antigenicity versus Immunogenicity |      |
| Haptens & Epitopes                           |      |

**UNIT II**

|   |      |
|---|------|
| Immunoglobulins: Structure and Function | 0.75 |
| Major Histocompatibility Complex        |      |
| Antigen processing and presentation     |      |
| Structure and functions of BCR & TCR    |      |

**UNIT III**

|  |     |
|--|-----|
| Cytokines  | 0.5 |
| The Complement System  |     |
| Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis |     |
| Ab-dependent cell mediated cytotoxicity (ADCC)                           |     |

**UNIT IV**

|   |     |
|---|-----|
| Overview of Hypersensitivity and Autoimmunity | 0.5 |
| Introduction to Transplantation               |     |
| Vaccines: Active and Passive Immunization     |     |

**UNIT V**

|  |     |
|--|-----|
| Introduction to Monoclonal Antibodies and Hybridoma technology   | 0.5 |
| Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence. |     |

**Recommended Books:**

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

**Paper VIII: SOLS/BT/C 008. Microbiology & Microbial Genetics**

No. of Credits = 3

**UNIT I**

Classification of living organisms and general account of microorganisms: Bacteria, Fungi and Viruses. 0.5

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. 0.5

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). 0.5

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

Microbial metabolism: Overview of Energy production and utilization, N<sub>2</sub> 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, (9<sup>th</sup> ed.) Pearson Education, Inc, 2009.
2. Prescott, Harley & Kliens: Microbiology (7<sup>th</sup> ed.) McGraw-Hill International Edition, 2008.
3. Michael J. Peleazar, E.C.S. Chan, Noel R. Krieg: Microbiology (5<sup>th</sup> ed.) Tata McGrall-Hill, 2008.
4. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (8<sup>th</sup> ed.) Jones & Bartlet Publ. 2007.



**Paper IX: SOLS/BT/C 009. Molecular Endocrinology & Enzymology**

No. of Credits = 3

**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. 0.75

**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. Biosynthesis of steroid hormones: Steroidogenesis, cellular sites of synthesis. Physiological actions of androgens. ABP, estrogen, progesterone. Hormonal control of Estrus / Menstrual cycle. Brief introduction to female & male infertility (causes and diagnosis). 0.75

**UNIT III**

Biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions. Stress & Adrenal. 0.5  
 Phytohormones: Introduction to plant growth regulators. Auxins, Gibberlins, Cytokinins  
 Ethylene: A volatile hormone, Triacntanol, Brassins, Polyamines and Abscisic acid, its role and function. Photomorphogenesis, Growth response to temperature.  
 Environment & Hormonal control of flowering in plants.

**UNIT IV**

Historical perspectives of enzyme 0.5  
 Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, 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.  
 Enzyme inhibition: types of inhibition, determination of  $K_i$ , suicide Inhibitor.

**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. 0.5  
 Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Concerted and sequential models. Isozymes special reference to lactate dehydrogenase. Ribozymes.

**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: SOLS/BT/C 010. Biomaths, Biostats, Computers Programming & applications**

No. of Credits = 3

**UNIT I**

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

**UNIT II**

Importance of statistics in biomedical research. 0.75  
 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**

Chi square test-characteristics of Chi square test, 0.5  
 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**

Introduction to algorithm, flowchart, problem solving methods, 0.75  
 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**

Introduction to Computers: Mini, micro, mainframe and super computers. 0.5  
 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 (4<sup>th</sup> ed.) Jaypee Bros. 1984.
6. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 1993.
7. D. Rajaraman & V. Rajaraman: Computer primer (2<sup>nd</sup> 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 (2<sup>nd</sup> ed.), TMH Publishing Company Ltd., New Delhi.

**S0LS/BT/SS 01: Epigenetics and Cancer Biology**

No. of Credits = 3

**UNIT – I**

Introduction, growth characteristics of cancers cells; Morphological and ultrastructural properties of cancer cells. Types of growth: hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Differences between benign and malignant tumors. Epidemiology of cancer. 0.75

**UNIT –II**

Cancer biology and biochemistry- Aberrant metabolism during cancer development; Paraneoplastic syndromes; Tumor markers; cellular protooncogenes- oncogene activation. Growth factors-EGF, TNF- and TGF- and growth factor receptors. Signal transduction in cancer. Role of transcription factors. 0.5

**UNIT -III**

Carcinogenesis- radiation and chemical carcinogenesis- stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis -DNA and RNA Viruses. Hormone mediated carcinogenesis in humans. 0.5

**UNIT – IV**

Cell Cycle Regulation-Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Telomeres, Telomerase, and Immortality; cell- cell interactions, cell adhesion-invasion And metastasis - VEGF signaling, angiogenesis; Epigenetics-Role of DNA methylation in gene silencing- epigenetic silencing of tumor-suppressor genes; Apoptosis in cancer-Cell death by apoptosis, role of caspases; Death signaling pathways-mitochondrial and death receptor pathways. 0.75

**UNIT V**

Detection of Cancers, Prediction of aggressiveness of Cancer, Different forms of therapy, Chemotherapy, radiation Therapy, and Immuno therapy: advantages and limitations. Epigenetics of cancer, Identification of targets for drug development. 0.5

**Recommended Books:**

1. The Biological Basis of Cancer: R. G. McKinnell, et al 2nd Ed, Cambridge University Press, 2006.
2. The Biology of Cancer: R. A. Weinberg. Garland Science. 2006.
3. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication.
4. Virology a practical approach, Maly B.W.J. IRL Press, Oxford, 1987.
5. Introduction to modern Virology, Dunmock N.J and Primrose.S.B., Blackwel Scientific Publications. Oxford, 1988.
6. An Introduction to Cellular & Molecular Biology of Cancer, Oxford Medical publications, 1991
7. Gene expression systems. Joseph M. Fernandez & James P. Hoeffler. Academic Press, 1999.
8. Cancer Biology IV Ed Volume2 Raymond W Ruddon M.D.(2007)
9. Cancer Biology (3rd\_Edition) Roger J.B. et al (2006)
10. Advances in Cancer Stem Cell Biology, Roberto Scatena, Alvaro Mordente & Bruno Giardina (Ed) - Springer(2012)

**S0LS/BT/SS 02: Industrial Microbiology**

No. of Credits = 3

**Unit I**

Microbes: Classical Domain and Kingdom concepts in classification of microorganisms; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal. Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing 0.5

**Unit II**

Microbial Growth: Ultra structure of Archaea (Methanococcus); Eubacteria (E.coli); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, stringent response, death of a bacterial cell. Microbial physiology: Physiological adaptation and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles. 0.75

**Unit III**

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines 0.5

**Unit IV**

Microbial Interactions and Infection. Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence. 0.5  
Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites;

**Unit V**

Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Bioprocess control and monitoring variables such as temperature, agitation, pressure, pH. Microbial processes-production, optimization, screening, strain improvement, factors affecting downstream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc. 0.75  
Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformations-steroids, antibiotics, alkaloids, enzyme/cell electrodes.

**Recommended Books:**

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinauer Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11<sup>th</sup> Edition, Pearson Prentice Hall, USA, 2006.

**Paper XIII: SOLS/BT/C 013. Bioinformatics, Legal Biotechnology & Bio Business Management**

No. of Credits = 3

**UNIT I**

Introduction to bioinformatics. Objectives, Application and Scopes, 0.5  
 IT in biology, bioinformatics resources on NET, Internet, Word 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), 0.5  
 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, 0.75  
 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, 0.5  
 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, Wiely 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 Genimics 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.

**Paper XIV: SOLS/BT/C 014. Recombinant DNA Technology & Genomics**

No. of Credits = 3

**UNIT I**

Introduction to Recombinant DNA technology and applications. 0.75  
 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. 0.75  
 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. 0.5  
 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. 0.5  
 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 (3<sup>rd</sup>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 XV: SOLS/BT/E 001 (a). Food and Beverages Biotechnology**

No. of Credits = 3

**UNIT I**

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes 0.5

**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. 0.5

**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. 0.5

**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. 0.75

**Recommended Books:**

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

**Paper XV: S0LS/BT/E 001(b). Research Methodology: Tools & Techniques**

No. of Credits = 3

**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. 0.5  
 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. 0.75  
 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. 0.5  
 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, 0.5  
 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, 1<sup>st</sup> Indian ed., Oxford University Press, 2006.
2. N. Gurumani: Research Methodology for Biological Sciences, 1<sup>st</sup> ed., MJP Publishers, 2008.
3. Wilson and Walker: Principles & Techniques, 4<sup>th</sup> ed. Cambridge low price ed., 1995.
4. Schmauder: Methods in Biotechnology, Taylor & Francis Publishers, 2003



**Paper XV: SOLS/BT/E 001(c). Chemical Sciences & Biomaterials**

No. of Credits = 3

**UNIT I**

Polymer materials: synthesis, characterization (inter polymers, biodegradable polymers, hydro gels, natural polymers, genetically engineered polymers, Bioactive polymers). 0.5

**UNIT II**

Biocompatibility of biomaterials, protein structure, interaction of proteins with synthetic materials; methods for evaluating protein adsorption. 0.5

**UNIT III**

Cell: interactions with proteins and materials, characterization of cell material interaction, Blood compatibility: platelets adhesion and aggregation, coagulation effects. 0.5

**UNIT IV**

The mechanical environment: In vitro assessment of blood compatibility, Interactions of bacteria with biomaterials: methods of sterilization, assessment of sterility. 0.5  
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, 20<sup>th</sup> editions, Lippincott, William and Wilkins.
2. Ansel's Pharmaceutical Dosage forms and drug Delivery System 8<sup>th</sup> 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

**Paper XVI: SOLS/BT/E 002(a). Pharmaceutical Biotechnology & Drug Designing**

No. of Credits = 3

**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. 0.5

**UNIT II**

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. 0.5  
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. 0.5

**UNIT IV**

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation. 0.5

**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.

**Paper XVI: SOLS/BT/E 002(b). Plant Biotechnology**

No. of Credits = 3

**UNIT I**

Clonal propagation/micropropagation and its applications to horticulture and forestry. 0.5  
 Production of disease free plants.  
 Incompatibility in plants. Methods to overcome incompatibility.

**UNIT II**

Somatic embryogenesis and production of synthetic seeds . 0.5  
 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: 0.75  
 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, 0.75  
 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.

**Paper XVI: SOLS/BT/E 001(c). Advanced Bioinformatics**

No. of Credits = 3

**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). 0.5

**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. 0.75

**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. 0.5  
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 0.5  
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

**S0LS/BT/SS 003: 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.)

**S0LS/BT/SS 004: 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.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 XIX: SOLS/BT/C 016. Environmental Biotechnology  
& Bioprocess Engineering**

No. of Credits = 3

**UNIT I**

Environmental Biotechnology: Concept, components of environment 0.75  
 Air pollution and its control through Biotechnology (deodorization, reduction in CO<sub>2</sub> 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**

Xenobiotics in Environment: Xenobiotic compounds, Recalcitrance, 0.5  
 Bioleaching 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**

Global Environmental Problems: Ozone depletion, UV-B, green-house effect and 0.5  
 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**

Introduction to fermentation processes and types of fermentation 0.75  
 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**

Bioreactors: Types and Design; medium rheology 0.5  
 K<sub>La</sub> 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.)

**Paper XX: SOLS/BT/C 017. Cell & Tissue Culture**

No. of Credits = 3

**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. 0.5

**UNIT II**

Animal cell culture medium: BSS & simple growth medium. Serum free media, Role of CO<sub>2</sub> 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. 0.5

**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. 0.75  
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. 0.75  
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 (3<sup>rd</sup> 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



**Paper XXI: SOLS/BT/E 004(a). Biomedical Technology**

No. of Credits = 3

**UNIT I**

Cellular Pathology: causes of cell injury, necrosis, biochemical mechanism, Ischemic and hypoxic injury. 0.75  
 Apoptosis (Biochemical features, mechanisms)  
 Immunological basis of diseases: Hypersensitivity (I – IV)  
 Autoimmune diseases  
 Preparation of polyclonal antisera: characterization of antisera, Immuno diagnostic – RIA, ELISA.

**UNIT II**

Mutations and genetic disorders. 0.5  
 Single gene disorders, Receptor proteins (hypercholesterolemia).  
 Cytogenic disorders (Trisomy, Klienfelters). Mutation in mitochondrial genes (LHDN), Fragile X Syndrome.

**UNIT III**

Types and grading of cancer. 0.75  
 Introduction to molecular diagnosis of cancer.  
 (Southern & Northern blot analysis, PCR based diagnosis).  
 Gene therapy, Immunotherapy and chemotherapy of cancer cells.

**UNIT IV**

Chemical mutagens. 0.5  
 Carcinogenic agents and their cellular interactions.  
 Radiation as health hazard.  
 (Types, measurements, effects & protective measures)  
 Introduction to DNA damage and repair mechanism.

**UNIT V**

Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic application of RDT) 0.5  
 Molecular diagnostic- direct gene diagnosis, Linkage analysis.  
 Nucleic acid sequences as diagnostic tools, SNPs, VNTRs, Non-invasive methodology. MRI, CT-SCAN.  
 Reproductive Health Technologies – ICSI, IVE.

**Recommended Books:**

1. Biomedical Technology and Devices Handbook, James E Moore, George Zouridakis, CRC Press (2004)

**Paper XXI: SOLS/BT/E 004(b). Fish Biotechnology**

No. of Credits = 3

**UNIT I**

Capsule on Molecular Biology. 0.75  
 Genome Organization: Gene organization in prokaryotes, eukaryotes & viruses  
 Structure of DNA: DNA replication, proteins & enzymes in DNA repair mechanism,  
 Gene model & Operon models, promoters and regulatory elements.  
 Extra genetic elements: plasmids, transposons, bacteriophages & Cosmids.  
 Transfer of Genetic Material: Transformation, conjugation and transduction.  
 Gene Expression: Transcription in prokaryotes & eukaryotes, initiation, elongation,  
 termination, Protein Synthesis: Translation: genetic code, genetic code in mitochondria,  
 codon bias, translation in prokaryotes & eukaryotes, post-translational modifications.

**UNIT II**

Gene Cloning- Restriction digestion: Restriction enzymes & DNA /RNA modifying 0.75  
 enzymes applications.  
 Gene Isolation & Identification: DNA extraction & purification vectors in cloning – plasmids,  
 cosmids & phages, yeast artificial chromosomes.  
 Construction of Genomic DNA & cDNA libraries, screening of libraries, isolation of gene  
 from colonies, Recombination expression systems & application.  
 Gene identification: PCR & applications, Nucleic acid & protein sequencing, Nucleic acid  
 probes & applications. Hybridization: S-Hybridization, N-Hybridization, W-Hybridization.

**UNIT III**

Fish genetic resources, Fish genome analysis. 0.5  
 Fish Transgenics: Transgenic technology, methods, selection & transfer of genes  
 application of transgenic in fisheries, transgenic fishes & their importance.  
 Recombinant Technology: Recombinant biologicals & importance in fisheries,  
 recombinant vaccines, recombinant diagnostics and prophylactics in fisheries.  
 Biotechnology application in fish aquatic system: Biosensors & application in fishes,  
 intellectual property rights, marine natural products.

**UNIT IV**

Hormonal Biotechnology: Hormones in fish, Biosynthesis, Physiological actions, 0.5  
 Mechanism of action. GnRH: Structure activity & use in breeding.  
 Endocrine & environmental control of reproduction. Cryopreservation of gametes.  
 Sex chromosomes & sex determination in fish, chromosome manipulations,  
 androgenesis, gynogenesis.

**UNIT V**

Genetic Manipulation: Ploidy & its induction & importance in fish breeding, sex 0.5  
 control, production of monosex populations.  
 National fish breeding programmes, stock improvement, Hybridization & cross breeding.  
 Genetic Markers: Molecular & Chromosomal markers. Molecular markers in strain,  
 species & population identification, marker assisted selections, development & use of  
 selection of molecular markers in fish genetic studies. Barcoding for fish genes.

**Recommended Books:**

1. Biotechnology and Genetics in Fisheries & Aquaculture by Andy Beaumont, K. Hoare. Wiley-Blackwell (2003)
2. Aquaculture and Fisheries Biotechnology, by RA Dunham. CABI Publishing-CABI (2004)
3. Biotechnology and Genetics in Fisheries and Aquaculture by Andy Beaumont, P Boudry, K Hoare. Wiley-Blackwell (2010)

**Paper XXI: SOLS/BT/E 004(c). Immunotechnology**

No. of Credits = 3

**UNIT I**

Organization & Expression of Immunoglobulin Genes: Multigene Organization of, Genes Variable -Region Gene Rearrangements, Generation of Antibody Diversity, Class Switching among Constant-Region Genes , Expression of Ig Genes. 0.75

**UNIT II**

Monoclonal Antibodies (mAb) & Hybridoma Technology: Introduction, production of monoclonal antibodies, Advantages and limitations of monoclonal Abs, Characterization & storage of monoclonal Abs, Commercial production of monoclonal antibodies, Monoclonal Ab produce by recombinant DNA technology, hybridoma technology Vs RDT application in diagnosis. 0.75

**UNIT III**

Engineered Monoclonal Antibodies: Chimeric and hybrid Monoclonal Antibodies, Monoclonal Antibodies constructed from Ig-gene libraries, Catalytic Monoclonal Antibodies(Abzymes). Cancer Immunotherapy 0.5

**UNIT IV**

General physiology of cytokines, Application of cytokine for therapy, Future development in cytokine therapy, Interferon colony stimulating factor Preparation of lymphokines by r-DNA Technology Organ Transplantation 0.5

**UNIT V**

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. Application of vaccines in diagnosis & therapy. 0.5

**Recommended Books:**

1. Practical Immunology, 4th Ed., F.C. Hay, O.M.R. Westwood, Blackwell Publishing, 2002
2. Selected Methods for Antibody and Nucleic Acid probes, Volume1, S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Cold Spring Harbor Laboratory Press, 1993.
3. Antibodies Laboratory Manual, Ed Harlow, David Lane, Cold Spring Harbor, Laboratory Press, 1988.

**S0LS/BT/SS 05: Enzyme Technology**

No. of Credits = 3

**Unit-I**

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. 0.5

**Unit-II**

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<sub>max</sub>, K<sub>m</sub>, K<sub>cat</sub> and their significance. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Single displacement and Double displacement reaction. 0.75

**Unit-III**

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. 0.5

**Unit-IV**

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. 0.75

**Unit-V**

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. 0.5

**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

**S0LS/BT/SS 06: 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, ΦX174, 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