**BACHELOR OF BIOTECHNOLOGY (FOUR YEARS) PROGRAM**

**FIRST YEAR**

**Semester I**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT-111 | Fundamental of Genetics  | 3 |
| BT-112 | Physical Chemistry | 3 |
| BT-113 | Biology-I | 3 |
| BT-114 | English-I | 3 |
| BT-115 | Islamic Studies | 2 |
| BT-116 | Pakistan Studies | 2 |
| **First Semester Total** | **16** |

**Semester II**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 121 | Introductory Biotechnology  | 3 |
| BT- 122 | Cell Biology | 3 |
| BT- 123 | Biology- II | 3 |
| BT-124 | English-II | 3 |
| BT-125 | Maths-I | 3 |
| BT-126 | General-I (Basics in Computer)  | 3 |
| **Second Semester Total** | **18** |

**SEMESTER I**

**FUNDAMENTALS OF GENETICS**

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| **BT-111 (3 Credit hours)**  |

**Course Contents:**

Brief history of genetics, Genes. Chromosomes. Mitosis and Meiosis. Theory of heredity, the mechanism of Mendelian inheritance. Test cross and back cross. Modification of 3:1, incomplete dominance, co-dominance. Lethal genes. Multiple alleles. Gene interaction i.e. modification of 9:3:3:1 ratio, and 9:3:4. Sex linked inheritance. Regulation of gene expression. Mutation. Chromosomal aberration, Changes in chromosome number (euploidy, aneuploidy). Structural changes in chromosomes (deficiency, duplication, inversion and translocation). Qualitative and quantitative traits. Linkage and crossing over. Gene mapping in eukaryotes. Extra nuclear inheritance. Protein synthesis. Population genetics; Hardy- Weinberg law.

**Practicals:**

 Identification of DNA in plant material (Feulgen staining). Study of chromosomes morphology and variation in chromosome number. Culture of Drosophila. Study of salivary glands chromosomes of Drosophila. Smear preparation techniques to study mitosis and meiosis. Blood grouping.

**Recommended books:**

1. Andrew P (2000) 5th edition, ‘Genetic analysis’ Mc Graw Hill Inc.
2. Levine P (1992) 2nd edition, ‘Genetic’ Modern Biology Series.
3. Strachan S, Andrew P (2004) 3rd edition, ‘Human Molecular Genetics’ BIOS Scientific Publishers Ltd.
4. Snustad, S (2003) 3rd edition, ‘Principles of Genetics’ John Wiley and Sons.

**PHYSICAL CHEMISTRY**

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| **BT-112 (3 Credit hours)**  |

**Course Contents**

1. **Solutions and Solubility:**

Various concentration terms like Normality, Molarity, Mole fraction, Percent solution, W/w, W/v, V/v, solubility, solubility product, factors effecting solubility, pH, Buffer solution, Physiological buffer, Buffer activity, titration curves, acid base indicators**.**

1. **Chemical Kinetics:**

Introduction, Type of chemical reaction, exothermic and endothermic reaction, rate and rate expression, order and molecularity of reaction, Zero order, 1st and 2nd order reaction, Various factors effecting rate of chemical reaction. The kinetics of enzyme catalyzed reaction and enzyme inhibitions.

1. **Colloids:**

Introduction, Classification, Preparation, Purification, Properties and application of colloid, colloid and dialysis.

1. **Nuclear Chemistry:**

Introduction, Natural and Artificial radioactivity, Properties of Alpha, beta and gamma particles. Radioactive decay and half life, detection and measurement techniques, fission and fusion reaction, radio tracers. Biological and diagnostic application of radioactive isotopes, Metal ions in carcinogenesis and in anticancer battle.

1. **Miscellaneous Process:**

Osmosis and osmotic pressure, adsorption and theory of adsorption, sterilization and disinfection i.e. dry heat, Moist heat, radiation, Gaseous sterilization, Aseptic techniques.

**Recommended Books:**

1. J. Fisher and J.R. Arnold (2001) 1st edition, ‘Chemistry for Biologist’, Bios scientific publisher Ltd. Oxford UK
2. M. Satake, Y. Hayashi and M.S Sethi (2003) 2nd Edition, ‘Bio physical chemistry’, Discovery Publishing House. New Delhi.
3. A.K. Das (2002) 4th edition ‘Bio organic Chemistry’ CBS publisher and distributors.
4. C. Raymond (1998), 2nd Edition. ‘Chemistry with application to biological system’, Oxford Publisher Co.

**BIOLOGY-I**

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| **BT-113 (3 Credit hours)**  |

**Course Contents:**

Brief introduction to Plant kingdom. **Viruses**; General morphology, biochemical nature and biological importance of virus. **Bacteria**; Introduction, morphology, structure, classification and biological importance of bacteria. **Fungi**; General introduction and structure, economic importance along with pathogenicity. Phytophthora, Ustilago, Puccinia, Penicillium, Claviceps, Yeast and Agaricus. **Algae**; General introduction and structure, economic importance of Cyanophyta, Chlorophyta, Bascilariophyta, Pheophyta and Rhodophyta. **Lichens**; General account, structure and biological importance of lichens. **Bryophytes**; General morphology, reproduction and biological importance with reference to Marchantia, Anthoceros and Polytrichum. **Pterodophytes;** General morphological account, reproduction, economic importance with reference to Adiantum and Marsilea. **Gymnosperms;** General morphology, distribution and economic importance of Conifers. **Angiosperms**; General introduction, economic importance with special reference to the family; Rosaceae, Fabaceae, Solanaceae, Poaceae.

**Practicals:**

Study of the representatives of the above groups. Field trips to the various locations for collection. Field observation and submit their collection at the time of examination.

**Recommended Books**:

1. Farrukh H, Ihsan I (2004), 1st edition, ‘A text book of botany’ Printman Peshawar.
2. Kumar H (1989) 1st edition, ‘Introductory Phycology’ East West Press India.
3. Vashisheta P (1990) 1st edition, ‘Pteredophyta’ S. Chand Series
4. Vashisheta P (1990) 1st edition, ‘Gymnosperms’ S. Chand Series
5. Vashisheta P (1990) 1st edition, ‘Taxonomy of Angiosperms’ S. Chand Series

**ENGLISH-I:**

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| **BT-114 (3 Credit hours)** |

**Course Contents:**

Listening and comprehension skills; Listening for meaning, Listening for pronunciation, responding to an oral discourse, turn taking reading skills, speed reading skinning, scanning, word attack skills, text attack skills, Vocabulary building (roots and affexis), textual organization, Writing skills; outlining, Textual organization, textual pattern general specific cause effect, comparison/ contrast classification, argument, description, cohesive links, punctuation, summarizing and paraphrasing composition, study skills, taking notes from a text, semantic makers, using abbreviations, dictionary and reference skills, preparing for seminar.

**ISLAMIC STUDIES:**

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| **BT-115** **(2 Credit hours)** |

**PAKISTAN STUDIES:**

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| **BT-116 (2 Credit hours)** |

**SEMESTER II**

**INTRODUCTORY BIOTECHNOLOGY**

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| **BT-121 (3 Credit hours)**  |

**Course contents:**

Historical background. Biotechnology--- an interdisciplinary pursuit, scope and application. Genetic engineering; History and application. Genome organization and basic tools of genetic engineering (Isolation, cutting, ligation etc). Mechanism of gene transfer, transfection and vectors. Enzyme technology; introduction, nature, classification and action, application of enzyme in genetic engineering and protein engineering, introduction to the role of enzymes in industrial product synthesis. Tissue Culture; Importance, concept of totipotency, history of tissue culture. Details of culture techniques (ex-plant, sterilization, growth, differentiation etc). Bioprocess and fermentation technology; introduction, principle of microbial growth. Important product formation. Bioreactor/Fermenter technology (Introduction and principle). Biotechnology and medicine; introduction pharmaceuticals and bio-pharmaceuticals , antibiotics, vaccines etc. Introduction to gene therapy and AIDS. Biotechnology in Agriculture and forestry; introduction, disease and resistant herbicide plants, micro propagation virus –free potatoes, herbicide resistant crops (Bt crops). Biotechnology for better animal production. Food and beverage technology: Introduction, food and beverages fermentation, Public acceptance and safety.

**Recommended books**

1. William J, Thieman J, Michael A (2003) 2nd edition, ‘Introduction to Biotechnology’ McGraw Hill Book company Inc.
2. Dubey R (2000) 1st edition, ‘A textbook of Biotechnology’ S Chand Publications.

**CELL BIOLOGY**

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| **BT-122 (3 Credit hours)**  |

**Course content:**

 **Cell structure and function**; Plasma membrane, cell wall, transport of materials through the plasma membrane, cytoplasm- its properties. **Cell chemistry;** inorganic compounds (Water and electrolytes), organic compounds (Carbohydrates, Lipids, Proteins, Vitamins, Nucleic acid, enzymes). **Organelles;** Endoplasmic reticulum, Golgi apparatus, Lysosomes, Peroxiosomes, Micro bodies, Vacuoles, Ribosomes, Mitochondria, Plastids, Centrioles. **Nucleus**: Nuclear membrane, nucleoplasm, Chromatin, Hereditary material, protein synthesis. Introduction to cellular metabolism. **Cytoskeleton**; Microfilaments and microtubules. **Surface feature of cell**; Microvilli, desmosomes, Plasmadesmata, Junction. **Organs of locomotion**; Cilia, flagella and other special features. **Prokaryotic cell**; structure of bacterial cell, differences between prokaryotic and eukaryotic cell. Introduction to cell signaling.

**Practicals:**

Light electron microscope i.e. SEM and TEM. Membrane permeability, Preparation and staining of histological slides. Mitosis and cell cycle. Meiosis in grass hopper. Osmosis by plant tissue, prepared slides survey. Cell organelles separation by differential centrifugation. Eukaryotic and prokaryotic cell.

**Recommended books:**

1. David E (1997) 1st edition, ‘ Cell Biology-organelles structure and function’ Jones and Bartlett Publishers, Bostan, London.
2. Gerald K (1996) 4th edition, ‘ Cell and Molecular Mycology’ Macmillan New York and London.

**BIOLOGY-II**

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| **BT-123 (3 Credit hours)**  |

**Course contents:**

 Introduction to animal kingdom. **Protozoa:** General organization with economic importance to Leishmania, Trypanosoma, Entamoeba, Giardia and Plasmodium. **Porifera**: General organization and importance of sponges. **Coelenterates:** General organization and economic importance of Collenterates (Coral reefs and polymorphism). **Platyhelminthes:** General organization and economic importance of Fasciola hepatica and Taenia solium. **Nematoda:** Diagnostic features and biological importance of Ascaris. **Annelida:** Diahnostic features and economic importance of annelids with special reference to leech. **Molluska**: Characteristics and economic importance of mollusks with special reference to fresh water mussel. **Arthopoda**: Diagnostic features of the phylum and economic importance of honey bee and silkworm. **Echinodermata**: Diagnostic features of echinodermates with special reference to starfish. **Vertebrata:** Diagnostic features of the five classes. Structure and function of the digestive, circulatory, respiratory, excretory, nervous, endocrine and reproductive systems of Rabbit.

**Practicals:**

General survey of each phylum and group from invertebrata to vertebrate. Collection and identification of animal species. Visit to wild life

**Recommended books:**

1. Lowenstein O, Parker T, Haswll A (1998) 2nd edition, ‘A text book of Zoology’ Volume I/II Macmillan Student edition.
2. James C (1998) 2nd edition, ‘Laboratory manual for the science of Zoology’ McGraw Hill Inc.

**ENGLISH-II**

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| **BT-124 (3 Credit hours)** |

**Mathematics-I**

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| **BT-125 (3 Credit hours)** |

**Course contents:**

**Section A**

Matrices and determinants; addition, subtraction and multiplication of matrices, inverse of a matrix, Crammer’s rule, solution of simultaneous equations with matrices. Complex numbers, algebra of complex numbers. Series and sequences. Vectors, Unit vectors, the three dimensional coordinates of a vector, addition and subtraction of vectors, scalar and vector product.

**Section B**

The derivatives, limits, rates of change, definition of the derivative, techniques for finding the derivatives, derivative of products and Quotients, Chain rule. Continuity and differentiability. Applications of the derivatives; Increasing and decreasing functions, relative extrema, absolute extrema, concavity the second derivative Test and curve sketching, applications of extrema, implicit differentiation, related rates, differentials. Exponential and logarithmic function; exponential function, logarithmic functions derivative of logarithmic function, derivative of exponential function, application of growth and decay. Integration, Anti-derivatives, substitution, area and definite integrals fundamental theorem of calculus, area between two curves. Techniques and applications of integration; integration by parts, numeral integration, applications of integration: Volume and average value improper integrals. Functions of several variables, partial derivatives, maxima and minima, lagrange multipliers, the least square line: the minimization application. Total differentials and Approximations.

**Recommended Books:**

1. Peter T (1998) 2nd edition, ‘Basic Mathematics for chemist’ John Willey and Sons.
2. Keeddy M (1989) 2nd edition, ‘Algebra and trigonometry’ Addison Wesley.
3. Margaret L, Charles D (1996) 5th edition, ‘Calculus with application, Brief version’. Scott Foresman and Company. Glenview, Illons London, England.

**GENERAL-I (Basics in Computer)**

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| **BT-126 (3 Credit hours)** |

**SECOND YEAR**

**Semester III**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 211 | Microbiology  | 3 |
| BT- 212 | Molecular Biology | 3 |
| BT- 213 | Organic Chemistry | 3 |
| BT- 214 | Biochemistry | 3 |
| BT-215 | Maths-II | 3 |
| BT-216 | General-II (Social Psychology) | 3 |
| **Third Semester Total** | **18** |

**Semester IV**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 221 | Metabolism- I | 3 |
| BT- 222 | Nucleic acid  | 3 |
| BT- 223 | Animal Physiology | 3 |
| BT- 224 | Plant Physiology | 3 |
| BT-225 | English-III (Comm Skill) | 3 |
| BT-226 | General-III Basics of Financial Management) | 3 |
| **Fourth Semester Total** | **18** |

**SEMESTER III**

**MICROBIOLOGY**

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| **BT-211 (3 Credit hours)**  |

**Course Contents:**

Introduction to microbiology. The light microscope. Characterization and classification of microorganisms. Cultivation of Bacteria. Reproduction and growth. Pure culture and cultural characteristics of bacteria. Fungi; the molds and yeasts. General characteristics of viruses. Control of microorganism; fundamentals of control, control by physical and chemical agents, antibiotics, chemotherapeutic agents. Microorganisms and diseases; host-microbe interactions, specific and non-specific immunity, immunization in the prevention and treatment of infection, allergy and other forms of sensitivity, serological tests such as agglutination, haemagglutination, neutralization, etc. Human infectious diseases; airborne, food and water-borne, zoonoses. Infectious diseases of animals. Microbial ecology; environmental microbiology industrial, air, water (domestic water and sewage), foods and dairy products microbiology.

## Practicals:

 Microscope and prepared slides. Staining methods: preparation of smears, simple negative, gram, acid-fast, endospore, capsule, flagella staining and detection f mobility – hanging drop side. Cultivation of bacteria: transfer of bacteria-aseptic techniques, isolation of bacteria by dilution techniques, media preparation-special media for isolating bacteria. Control of microbial growth: physical methods of control: heat, UV radiation, etc. Chemical methods of control: disinfectants, antiseptics, and antibiotic and antimicrobial drugs sensitivity.

**Recommended Books:**

1. Prescott (2002) 5th edition, “Microbiology” Mc Graw Hill Book Company Inc.
2. Dubey R., Maheshwar D, (2002) 1st edition, “Text Book of Microbiology” S Chand Publication.

**MOLECULAR BIOLOGY**

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|  **BT-212 (3 Credit hours)**  |

**Course Contents:**

Genes (Structure, Regulatory region, promoter, and transcriptional unit, prokaryotic & eukaryotic) and genomes. DNA replication. RNA synthesis, RNA types, Posttranscriptional modifications (capping, polyadenyltion, splicing and editing). Protein synthesis (Genetic code and its characteristics, structure of t-RNA, Ribosomes, Detailed description of various steps in protein synthesis i.e. activation and aminoacylation of t-RNA, Initiation, Elongation and termination, Fidelity of protein synthesis) and Posttranslational modifications. Repair and recombination, Transposition, Regulation of gene expression in prokaryotes and eukaryotes.

## Practicals:

Estimation of proteins in serum and cytosol, SDS-PAGE, western blotting, determination of UV absorption spectra of proteins, nucleic acids. Determination of melting temperature of nucleic acid. Extraction of RNA, DNA and proteins. Measurement of RNA, DNA and protein concentrations.

**Recommended Books:**

1. Werner R (1992) 2nd edition, “Essential Biochemistry and Molecular Biology” Elsevier, N.Y.
2. DeRobertis E, (1987) 2nd edition, “Cell and Molecular Biology” Lead and Febiger, N.Y.
3. James D, Watson D (2003) 5th edition, “Molecular Biology of the Genes” W.H Freeman and Company.

4. Textbook of Biotechnology (Fundamentals of Molecular Biology) by S.K.Jain.

**ORGANIC CHEMISTRY**

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| **BT-213 (3 Credit hours)**  |

**Course Contents:**

Introduction to organic Chemistry. Classification and nomenclature of organic compounds. Basic concepts in organic chemistry (Resonance, Inductive effect, Tautomerism etc). Brief introduction to organic acids and bases. Nucleophiles, electrophiles. **Compounds containing sp-3 hybridized carbons**; alkanes, cycloalkanes and alkyl halides. **Compounds containing sp-2 or sp hybridized carbons**; alkenes, aromatic hydrocarbons, alkynes. **Stereochemistry;** Functional group containing heteroatoms; compounds containing sp3 hybridized nitrogen (ammonia and amines), Compounds containing sp-3 hybridized carbons (imines), Compounds containing sp-3 hybridizedoxygen (Alcohols, Ethers), Compounds containing sp-2 hybridized oxygen (Aldehydes, Ketones, carboxylic acid, Esters, Acid halides, Acid anhydrides and Amides), Compound containing sulfur (thiols), Physical methods of separation and purification of organic compounds.

**Practicals:**

1. Introduction to laboratory safety precautions
2. Determination of melting point
3. Purification of a liquid by distillation
4. Steam distillation
5. Purification of a compound by sublimation
6. Fractional distillation
7. Paper Chromatography of ink mixture and amino acids mixtures
8. Thin layer chromatography
9. Preparation of nitrobenzene
10. Preparation of m-dinitrobenzene
11. Preparation of oxalic acid

**Recommended Books:**

1. Harold H, David J, Lesli E (1995) 9th edition, ‘Organic Chemistry -A short course’ S Chand and Company Ltd. Ram Nagar, New Delhi
2. Graham S (2001) 4th edition, ‘ Fundamentals of organic chemistry’ John and Sons, Inc. New York
3. Francis A (2001) 3rd edition, ‘ Organic Chemistry’ International Ed. The McGraw-Hill companies, Inc. New York, New Delhi
4. Francis A (1996) 3rd edition, ‘Organic chemistry’ Mc Graw Hill inc.

**BIOCHEMISTRY**

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| **BT-214 (3 Credit hours)**  |

**Course Contents:**

 Amino acids and proteins; classification, structure, functions, methods of separation. Carbohydrates, lipids, nucleic acids/ polynucleotide; classification, structure, function, methods of separation. Enzymes; classification, factor affecting activity of enzymes, mechanism of action, coenzymes. Vitamins; classification, structure, function and properties.

**Practicals:**

1. Determination of Pka values of dicarboxylic acids.
2. Titration curves of amino acids.
3. Quantitative estimation of amino acids by Ninhydrin, Biuret, Folin- Lowry Method.
4. Qualitative tests for carbohydrates
5. Qualitative tests for amino acids.
6. Isolation of casein from milk and determination of free amines and group of casein and other proteins.
7. Benedict’s test for reducing sugar, Iodine test for polysaccharides.
8. Isolation and assay of glycogen from liver and skeletal muscles of rats.
9. Determination of Saponification value of Fats.
10. Determination of Iodine Numbers of Fats.

**Recommended Books:**

1. Stryer L, Berg J, Tymoczky J (2002) 5th edition, “Biochemistry” W.H Freeman and Company.
2. David L, Nelson P, Michael M, Lehninger P (2004) 4th edition, “Principle of Biochemistry” W.H. Freeman & Company.
3. Donald V (2004) 3rd edition, “Biochemistry” Wiley Text Books Corp.
4. Christopher K. Mathews P, Kensal E, Kevin G (1999) 3rd edition, “Biochemistry” Pearson Education Company.
5. Murray R, Granuea D, Mayer P, Rodwell V (2003) 26th edition, “Harper’s Illustrated Biochemistry” Mc Graw Hill Inc.

**MATHS-II**

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| **BT-215 (3 Credit hours)** |

**GENERAL-II (Social Psychology)**

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| **BT-216 (3 Credit hours)** |

**SEMESTER IV**

**METABOLISM-I**

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| **BT-221 (3 Credit hours)**  |

**Course Contents:**

 Introduction to metabolism; carbohydrate metabolism, sources of glucose to the organism (exogenous and endogenous) digestion and absorption of carbohydrates, utilization and storage of glucose, anaerobic oxidation of glucose, aerobic oxidation of glucose (TCA cycle), alternate pathways of carbohydrate metabolism (HMP shunt), gluconeogenesis, glycogen metabolism. Electron transport chain.

Lipid metabolism; digestion, absorption and transport of lipids, utilization and storage of lipids, fatty acids, oxidation, outline of biosynthesis of fatty acids, glycosides phospholipids, glycolipids, sterols and steroids. Regulation of metabolism. Integration, controls and disorders of metabolic pathways related to carbohydrates and lipids.

### Practicals:

1. Determination of Acid value of Fats.
2. Determination of Lipid Composition of Wheat grain.
3. Variation of Serum Alkaline Phosphatase activity with enzyme concentration.
4. Effect of Substrate Concentration and inhibitors on ox heart Lactate Dehydrogenase.
5. Effect of temperature on the activity of α- amylase.
6. Yeast isocitrate Dehydrogenase, Allosteric enzyme.
7. lsolation of Muramidase from egg white. Fraction collector, (UV, VIS).
8. Separation of isoenzyme of lactate Dehydrogenase by electrophoresis on polyacrylamide gel (Equipment PAG).
9. Some properties of Lactate Dehydrogenase Isoenzymes.
10. Effect of Lipid composition on the permeability of a lipid monolayer.

**Recommended Books:**

1. Stryer L, Berg J, Tymoczky J (2002) 5th edition, “Biochemistry” W.HFreeman and Cvompany.
2. David L. Nelson P, Michael M. Lehninger P (2004) 4th edition, “Principle of Biochemistry” W.H. Freeman & Company.
3. Donald V (2004) 3rd edition, “Biochemistry” Wiley Text Books Corp.
4. Christopher K. Mathews P, Kensal E, Kevin G (1999) 3rd edition, “Biochemistry” Pearson Education Company
5. Murray R, Granuea D, Mayer P, Rodwell V (2003) 26th edition, “Harper’s illustrated Biochemistry” Mc Graw Hill Inc.

**NUCLEIC ACID**

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| **BT-222 (3 Credit hours)**  |

**Course Contents:**

Human genome organization; human chromosomes, gene structure, mutations, nuclear and mitochondria genome. Human multigene families; repetitive DNA sequences, pseudogenes. Expression of human genome; expression control at DNA, RNA, and protein levels, expression control at nucleosome level, genetic imprinting, X chromosome inactivation, immunoglobulin gene organization. Cloning of human genes, cDNA cloning, positional cloning of genes. Mutation detection. Human gene structure and function.

## Practicals:

 Determination of UV absorption spectra of Nucleic Acids and quantification of DNA and RNA. Preparation of Plasmid DNA. RNA extraction and purification. Southern blot and hybridization. RNA electrophoresis. Amplification of human gene on PCR. Separation of alleles on vertical non-denaturing gel.

**Recommended Books:**

* 1. Glick B, Pasternack J (1998) 2nd edition, “Molecular Biotechnology” ASM Pres Washington DC.

2. Strachan T, Andrew P (2004) 3rd edition, “Human Molecular Genetics” Willey and Sons.

3. Stryer L, Berg j, Tymoczky J (2002) 5th edition, “Biochemistry”W.H Freeman and Company.

**ANIMAL PHYSIOLOGY**

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| **BT-223 (3 Credit hours)**  |

**Course Contents:**

Introduction. Homeostasis. Biomembranes. Membrane potential. Nervous system; sensory physiology - chemoreception, mechanoreceptor photoreception. Muscle physiology; introduction, molecular structure, muscle contraction, skeletal muscle mechanics, - skeletal muscle movement, smooth and cardiac muscle, invertebrate muscles. Cardiac physiology; introduction to cardiac cycle, vertebrate & invertebrate. Cardiovascular system; introduction, solute exchange, blood pressure. Respiratory system; introduction, gas exchange & transport, control. Respiratory system of amphibians, reptiles and birds. Respiratory system; the vertebrate gill and water breathing. Other methods of gas exchange. Urinary system; vertebrate kidney, osmoregulation, extra renal osmoregulatory organs.

Fluid and acid-base balance. Digestive system - specialized digestion.

**Practicals:**

Dissection of frog and study of digestive, reproduction, arterial, venous and respiratory system. Blood cells. Dissection of pigeon and study of digestive, excretory, respiratory and reproduction system. Dissection of mouse and study of digestive, reproductive, excretory system and blood cells (White blood cells, red blood cells). Study of Nervous tissue (brain) of Mammals.

**Recommended Books:**

1. Richard W, Gordon A, Margaret A (2004) 1st edition, “Animal Physiology” Mc Graw Hill Inc.
2. Guyton (2000) 9th edition, “Text book of medical physiology” Mc Graw Hill Inc.

**PLANT PHYSIOLOGY**

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| **BT-224 (3 Credit hours)**  |

**Course contents:**

### Plant structure; introduction to tissue and tissue system in primary plant body. Water relations; plant-soil-atmosphere continuum. (an overview). Physico-chemical properties of water. Water in the soil and its potentials. Water absorption. Plant mineral nutrition; importance of minerals, their absorption and role in plant development. Ascent of sap; path and theories. Mechanism of phloem transport. Leaves and atmosphere; gaseous exchange, mechanism and factors affecting stomatal movement. Photosynthesis; concept, an overview of the mechanism. Pigments and photosynthetic activity, photosystem I and II, photophosphorylation and its mechanism, dark reactions, (CO2 reduction). C4 and CAM pathways. Respiration; concept, respiratory substrates and quotient, aerobic and anaerobic respiration, Glycolysis, electron transport, ATP formation and oxidative photophosphorylation, factors affecting respiration. Fermentation, control and factors affecting respiration. Plant growth and development; phytohormones and role in biological processes, phytohormones-kinds, structure and mechanism of action, physiological effects of auxins, gibberellins, cytokinins, abscisic acid and ethylene, control of flowering metabolic aspects of senescence, role of hormones in seed germination, aging and death. Photoperiodism and mechanism. Vernalization.

**Practicals:**

Identification of C3 and C4 leaves. Identification of stomatal types. Study of special epidermal cells. Study of transverse section of root. Study of transverse section of stem. Determination of water potential by Chardakov’s method. Effect of light on stomatal movements. Extraction of chlorophyll from leaves and separation of pigments. Measurement of relative growth rate (RGR). Measurement of specific leaf area and plant activity. To observe that oxygen is released during photosynthesis.

**Recommended books**

1. Kochar P, Krishna N (1994) 2nd edition, “A text book of plant physiology” Mc Graw Hill Book Company Inc.
2. Giese C (1999) 2nd edition, “Cell Physiology” Mc Graw Hill Book Company Inc.
3. Jain K (2000) 3rd edition, “Fundamentals of plant physiology” Mc Graw Hill Book Company Inc.
4. Ihsan Ilahi “Plant Physiology: Biophysical process in Plants” University Grant Commission, Islamabad.
5. Ihsan Ilahi “Plant Physiology: Biochemical process in Plants” University grant commission, Islamabad.

**ENGLISH-III (COMMUNICATION SKILLS)**

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| **BT-225 (3 Credit hours)** |

GENERAL-III (BASIC OF FINANCIAL MANAGEMENT )

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| **BT-226 (3 Credit hours)** |

Chapter 1st: introduction:

* + 1. Introduction to Management:

Management, Process of Management, types of Management

* + 1. Introduction to Financial Management

Financial Management, types of Financial Management, (Personal finance, corporate finance).

* + 1. Financial Techniques, Concepts

Chapter 2nd: Working Capital Management

* + 1. Cash budget:

Need of Cash, Cash Importance, Cash Book Maintenance, Cash Flow Statement.

* + 1. Credit

Credit policy, Advantages / disadvantages of credit trade Stock

* + 1. stock control.

Chapter 3rd: Management of fixed assets

* + - 1. Depreciation
			2. Insurance

Chapter 4th: Mathematical Management.

1. Calculation of Interest Rate simple interest rate, compound interest rate, present value techniques.
2. The methods of appraising an investment proposal.

Pay back. Average Rate of Return, Internal Rate of Return, Present Value, Net Present Value

**THIRD YEAR**

**Semester V**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 311 | Enzymology | 3 |
| BT- 312 | Environmental Biotechnology  | 3 |
| BT- 313 | Metabolism-II | 3 |
| BT- 314 | Bioinformatics-I | 3 |
| BT- 315 | Plant Biotechnology | 3 |
| BT- 316 | Cellular Signaling  | 3 |
| **Fifth Semester Total** | **18** |

**Semester VI**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 321 | Immunology | 3 |
| BT- 322 | Animal Biotechnology | 3 |
| BT- 323 | Recombinant DNA | 3 |
| BT- 324 | Medical Biotechnology | 3 |
| BT- 325 | Techniques in Biotechnology-I | 3 |
| BT-326  | Bioinformatics-II  | 3 |
| **Sixth Semester Total** | **18** |

**SEMESTER V**

**ENZYMOLOGY**

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| **BT-311 (3 Credit hours)**  |

**Course Contents:**

###  Enzymes, nomenclature and classification of enzymes. Co-enzymes. Co-factors, prosthetic group, holoenzymes, proenzymes & core-enzymes. General properties of enzymes; nature of enzymes, effect of different factors on enzymes activity, effect of temperature, effect of pH, effect of substrate concentration. Monomeric & oligomeric enzymes. Soluble & membrane-bound enzymes. Regulation of enzymes; regulatory enzymes as pace makers, regulatory enzymes as an allosteric enzymes. Enzyme inhibition. Enzymes catalysis.

Immobilization of enzymes; introduction, different techniques used, entrapment (gel entrapment), fiber entrapment, micro-encapsulation, carrier binding (physical binding), ionic binding, covalent binding, metal binding. Iso-enzymes; introduction, simple structure of isoenzymes, formation of isoenzymes, identification of isoenzymes, significance of isoenzymes. Diagnostic applications of certain enzymes, quantitative analysis of enzymes. Enzymes structure; molecular structure, number of peptide chains, molecular weight, amino acid sequence, structure & configuration of enzymes, determination of active center.

### Enzyme kinetics; Michaelis-Menten equation, LineWeaver-Burk’s equation. Significance of Burk’s plot to determine Km Value.

**Practicals:**

Investigation of enzymes in biological preparations: Extraction and purification of enzymes, enzyme assays. Instrumental techniques used in enzyme analysis. Estimation of amylase, acid protease, acid phosphates, lactate dehydrogenase (LDH). Effect of pH on enzyme stability and activity. Effect of temperature and time on the stability and proteolytic activity of enzyme. Effect of metal ions, inhibitors and activators on enzyme activity. Separation of LDH isozymes by electrophoresis.

**Recommended Books:**

1. Malcolam D (1964) 2nd edition, “Enzymes” Longman, Green & Co.
2. Butter W (2000) 1st edition, “Principles of Enzymes Biotechnology for Technological Applications” Butter Worth Heinman Ltd.
3. Murray R, Granuea D, Mayer P, Rodwell V (2003) 26th edition, “Harper’s illustrated Biochemistry” Mc Graw Hill Inc.
4. David L, Nelson P, Michael M, Lehninger P (2004) 4th edition, “Principle of Biochemistry” W.H. Freeman & Company.

**ENVIRONMENTAL BIOTECHNOLOGY**

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| **BT-312 (3 Credit hours)**  |

**Course Contents:**

Introduction to environmental biotechnology, importance and application of environment biotechnology, biodegradation, bioremediation, biochemical oxygen demand, chemical oxygen demand. Phytoremediation. Microbes in environment, biogeochemical cycles, environmental pollution, types and sources of pollution, types of pollutants in the environment, effect on community, types of different pollutants from different industries.Identifying novel microbial catalysis by enrichment culture and screening, general methods of making enrichment culture, selection of conditions and medium for the enrichment culture. Screening for specific biocatalytic reactions, biodegradation of organic compounds, factors affecting biodegradation, Requirements for biodegradation, types of biodegradation, biodegradation of organic compounds. Phenolic compounds, pesticides, hydrocarbons, polycyclic aromatic hydrocarbons, plastics, polychlorinated hydrocarbons, degradative Plasmids, microbes that harbour catabolic plasmids, catabolic plasmids of pseudomonas, TOL plasmids and substrates of TOL plasmids. Bioremediation, concepts of bioremediation, applicability of bioremediation, biodegradability of petroleum hydrocarbons, halocarbons, chlorophenols and nitroaromatics. Phytoremediation, application of phytoremediation, typical plants used in various phytoremediation applications, design of phytoremediation system, biofilm, facts about biofilm. Colonization of surfaces, environmental pollution management, water pollution,Water pollutants, pathogens in water, water purification, tests for measuring water purity, wastewater biotreatment, biotreatment of muncipal solid waste, composting , anaerobic conversion, vermiculture, biotreatment of waste air, bioreactors for air pollution control, advantages of bioreactors for waste air treatment. Introduction of biosensors, types of biosensors, environmental application of biosensors, biomonitoring.

Measurement in biomonitoring study, ecofriendly bioproducts for environmental health, biological control agents, biofertilizers, biomass energy, biofuels, biogas, Biosafety and biotechnology. Bioreators types, environmental protection. Authority laws.

## Practicals:

Enrichment for bacteria involved in sulfur cycle using a Winogradsky column. Isolation of Bioluminescent bacteria. Isolation of Magnetotactic bacteria. Mutualism between Algae and Cyanobacteria. The symbiotic relationship between Rhizobium and Leguminous plants. Biodegradation of wastes and pollutants. Cellulose decomposition. The biodegradation of petroleum. Bioleaching.

**Recommended Books:**

1. Chatterji A (2002) 2nd edition, “Introduction to Environmental Biotechnology”

 Prertice Hall of India Private Limited, New Delhi.

2. Bruce E, McCarty P (2001) 2nd edition, “Environmental Biotechnology” (Principles and Application), The McGraw Hill Companies, New York.

**METABOLISM II**

**Course Contents:**

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| **BT-313 (3 Credit hours)** |

Nitrogen metabolism; amino acids deamination reactions, urea cycle and its regulation, biosynthesis of essential and non-essential amino acids. Metabolic breakdown of essential and non-essential amino acids; amino acids as biosynthetic precursors. TCA cycle. Chemical nature and synthesis of ribonucleotides. Nucleotides degradation. Synthesis of nucleotide co-enzyme. Regulation of metabolism. Integration, controls and disorders of metabolic pathways related to amino acids and purine and pyrimidine metabolism.

**Practicals:**

1. Effect of Detergent and other membrane active reagents on the erythrocyte membranes.
2. Isolation of Chloroplast from Spinach leaves.
3. The evolution of Oxygen by isolated Chloroplasts- Hill oxidants (oxy- electrode ).
4. Respiration of mitochondria and oxidative phosphorylation (ultra centrifugation).
5. Determination of crude protein by micro-Kjeldahl`s method
6. Determination of protein by Bradford methods

**Recommended Books:**

1. David L. Nelson, Michael M (2004) 4th edition, “Principles of Biochemistry” W.H. Freeman & Company.
2. Donald Voet (2004) 3rd edition, “Biochemistry” Wiley Text Books.
3. Christopher K, Mathews K, Kensal E, Holde V, Kevin G. Ahern M (1999) 3rd edition, Biochemistry Publisher- Pearson Education.
4. Murray R, Granuea D, Mayer K, Rodwell V (2003) 26th edition, “Harper’s illustrated Biochemistry” Mc Graw Hill.
5. Stryer L, Berg J, Tymoczky J (2002) 5th edition, “Biochemistry” W.H Freeman and Company.
6. Lippincott Biochemistry
7. Medical biochemistry by Chattrjae.

**BIOINFORMATICS-I**

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| **BT-314 (3 Credit hours)**  |

**Course Contents:**

Introductory Bioinformatics: Biology Databases**,** DNA sequence databases (EMBL, GenBank, DDBJ), Protein sequence databases (SWISS-PROT), PIR. Genomes: Human Genome Project, Plant Genome Project (arabidopsis),. Sequence Analysis:  Pair wise and Multiple Sequence Alignment, Pattern Searches, Secondary Structure Prediction, Phylogenetic analysis, WWW-based sequence analysis tools

### Recommended Books:

1. Westhead D.R., Parish J. H. and Twyman R. M. (2003**),** The Instant Notes series: Bioinformatics.1st edition, BIOS Scientific Publishers Limited, Oxford,UK.
2. D. Higgins, W. Taylor (2001), Bioinformatics: Sequence, Structure, and Databanks. A practical Approach, Oxford University Press.
3. Andrew R. Leach (2003), Moleculor Modelling, Principles and Applications**.** AddisinWesley longman Limited.
4. Claverie, J.M and Cedric Notredame (2003), Bioinformatic – A. Beginner’s Guide, Wiley publishing, Inc, USA.

**PLANT BIOTECHNOOGY**

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| **BT-315 (3 Credit hours)**  |

**Course Contents:**

 Historical perspective. Media; introduction, composition, preparation and sterilization techniques. Concept and historical development of tissue culture techniques. Root, shoot, meristem and embryo culture. Hormonal control of organ formation. Preparation and cloning of single cells. Laboratory requirements and general techniques. Introduction, requirement and techniques, cell culture. Isolation of single cell. Suspension culture. Plant cell reactors (Batch cultures). Application of cell culture. Synchronization. Totipotency; introduction, cytodifferentiation and organogenic differentiation. Somatic embryogenesis; Embryogenesis and factors affecting the process. Induction, development and maturation of somatic embryos. Large scale embryo production and artificial (synthetic) seeds. From single cell to plant. Practical application of cellular totipotency. Haploid production; techniques. Androgenesis and factors affecting the process. Ontogeny of androgenic haploid. gynogenesis. Distant hybridization. Homozygous diploid development; applications and limitations. Triploid production techniques. Histology and cytology of cells. Organogenesis. Application of endosperm cultures. Protoplast Culture; isolation of protoplasts. Culture and regeneration. Protoplast fusion, their types and applications.

In vitro pollination and fertilization. Introduction, techniques and applications.

Germplasm storage; introduction, techniques and applications.

# Practicals:

Aseptic technique. Microscopy. Screening for contamination. Media preparation. Callus formation.

Selection and analysis of transformed cells. Tobacco anther culture. Micropropagation. Protoplast isolation. Cell culture. Embryo rescue

**Recommended Books:**

1. Purohit S (2001) 2nd edition, “Biotechnology Fundamentals and Applications” Agrobios (India).
2. Chawla H (2000) 2nd edition, “Introduction to Plant Biotechnology” Oxford and IBH Publishing Co. Pvt. Ltd.
3. Bhojwani S, Razdan M (1983) 3rd edition, “Plant Tissue Culture” Elsevier.

**CELLULAR SIGNALLING**

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| **BT-316 (3 Credit hours)**  |

**Course Contents:**

General principles of cell signaling: Types of signaling (paracrine, endocrine, autocrine, synaptic, gap junctions), combinatorial signaling, responses to some signaling molecules, primary and secondary responses to signaling molecules, Classes of cell-surface receptor proteins (G-protein linked receptors, Enzyme linked receptors, Ion channel linked receptors). Signal integration. Signaling via G-protein linked receptors: Classes of G-proteins (stimulatory, inhibitory). Signaling pathways by G-protein linked receptors (cAMP pathway, Ca pathway, interaction between cAMP and Ca pathways). G-proteins regulating ion channels, signal amplification, memory response. Signaling via Enzyme-linked receptors: Receptor guanylyl cyclase, Tyrosine specific protein kinases (SH2, SH3 domains containing proteins, Ras protein, Adaptor protein, MAP kinase activation) Tyrosine kinase-associated receptors, Protein tyrosine phosphatases, Serine/threonine protein kinases. Target cell adaptation: Due to receptor down-regulation, Due to downstream changes other than receptors. Cell division cycle: General stategy of cell cycle ( M-phase, G1 phase, S-phase, G2 phase) Central control system (cdk, cyclins) Cell division controls in multicellular organisms ( regulation of mammalian cell growth, growth factors) Study of Cancer cells (genes involved in the control of cell proliferation, intracellular signaling cascade). Study of biofilms: Interaction of various microorganisms, Development of a biofilm, Factors influencing the development of a biofilm.

**Recommended Books:**

* 1. Albert B, Bary D, Lewis J, Raff M, Roberts K, Watson J, (1994) 3rd edition, “Molecular Biology of the Cell” Garland Publishing Inc. N.Y.
	2. Frefielder D, Malcinski G, (1993) 2nd edition, “Essential of Molecular Biology” Elsevier, N.Y.
	3. DeRobertis E, Derobertis E (1987) 2nd edition, “Cell and molecular Biology” Lead and Febiger, N.Y.

**SEMESTER VI**

**IMMUNOLOGY**

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| **BT-321 (3 Credit hours)**  |

**Course Contents:**

An introduction to immunology, innate immunity, complement system and innate system, receptors of the immune system, induced innate responses to infection. The recognition of antigen, antigen recognition by B cell & T cell receptors, structure of typical antibody molecule, interaction of antibody with specific antigen, antigen recognition by T cells.Generation of lymphocytes antigen receptors, antigen presentation to T lymphocytes, signaling through immune system receptors development. Immunological memory. Immune system in health and disease. Allergy and hypersensitivity. Auto immunity and transplantation.

**Practicals:**

Non-specific resistance, blood group determination. Agglutination reactions: microtiter agglutination. Immunodiffusion, immunoelectrophoresis, radioimmunoassary, enzyme immunoassays, fluorescent-immunoassays. Immunochromatography.

Recommended Books:

1. Richard A, Thomas J, Janis K, Barbara A (2003) 5th edition, “Immunology” W.H. Freeman & Company.
2. William E, Md. Paul (2003) 5th edition, “ Fundamental Immunology” Lippincott Williams & Wilkins; Bk & Cdr.
3. Janeway C, Walport M (2001) 5th edition, “Immunobiology” Garland publishers.

**ANIMAL BIOTECHNOLOGY**

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| **BT-322 (3 Credit hours)**  |

**Course Contents:**

Introduction to animal biotechnology. Breeds of livestock in Pakistan; role of livestock in the economic development. Principles of animal cell and tissue culture; origin of concept, cell markers, cellular morphology, types of cells, primary and established cell lines, kinetics of cell growth, genetics of cultured cells, applications of animal tissue cultures. Techniques of animal cell and tissue culture; sources of cells, techniques of cell culture, equipments, the substrate on which cells grow in laboratory, media handling equipment, cell culture media, animal tissue culture media, culture procedures, preparation of animal material, primary culture, cell lines and cloning, somatic cell fusion, tissue culture, organ culture, whole embryo culture. Artificial animal breeding; artificial insemination and germ cell storage, ectogensis, amniocentesis, transplantation, cloning technique, in vitro fertilization, embryo transfer techniques, selective animal breeding ,hazards of artificial breeding. Transgenic animal technology; concept of transgene and transgenics, use of transgenics in animal agriculture and research models. Mouse transgenesis. Livestock transgenesis. Animal cloning. Animal pharming. Fish biotechnology; genetic requirements for transgenic fish development; characterization of transgenic fish ,application of transgenic fish in biotechnology. Animal health biotechnology. zoonotic diseases.

**Practicals:**

Demonstration of production of serum/Plasma. Preparation of Hank’s Balanced salt’s solution. Preparation of serum supplemented yeast extract medium. Establishment of a primary cell line of chicken fibroblast. Study of germ cells of animals.

Production of extenser. Study of transformed and non-transformed cells. Demonstration of embryo transfer techniques.

Recommended Book:

1. Ranga M (2004) 2nd edition, “Animal Biotechnology” Agrobios Publisher India.

 2. Dubey R (2004) 1st edition, “Text book of Biotechnology” S.Chand Publishers.

 3. Ranga/Shami (2003) 1st edition, “Fish Biotechnology” Agriobios Publishers.

**RECOMBINANT DNA**

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| **BT-323 (3 Credit hours)**  |

**Course Contents:**

Introduction to recombinant DNA technology. Restriction enzymes, DNA ligase, Polymerase etc. Cloning vehicles; plasmids, cosmids, lambda phage, choral phage shuttle vectors. Introduction of cloned genes into the host cells; transformation, transduction, particle gun, electroporation, liposome mediated, cultivation etc.Molecular biology of DNA transfer in plants through Agrobacterium tumefaciens, discovering of Ti plasmids and T-DNA, Opines, Expression of T-DNA genes, functional organization of the T-DNA, Ti plasmid as gene vector, caulimoviruses, Gemini viruses. RNA viruses, viroids. Analysis and expression of cloned gene in host cells; restriction enzyme analysis, southern blotting, northern blotting, in-situ hybridization, DNA sequencing. RFLP, PCR, RAPD, DNA finger printing, Ribozymes, DNA probes, antisense RNA, expression of cloned genes. DNA sequencing, reporter genes. Gene libraries-construction and analysis of cDNA, m RNA, isolation, cDNA synthesis, cloning and amplification of gene libraries, genomic DNA libraries, YACs, BACs, measuring activity of fused genes. Identifying the products of c DNA clones; changing genes, site-directed mutagenesis. Genetically modified plants and animals. Controlling the expression of transgenes. Transferring genes into animal oocytes, eggs, embryos and specific animal tissues. Applications of genetic engineering.

## Practicals:

Growth of bacteria on solid medium, preparation of bacterial culture, restriction enzyme digestion of DNA preparation, separation and identification of DNA fragment by agarose gel electrophoresis, purification of DNA fragmented by electroporation after digestion and separation on agarose, PCR, sequencing, preparation of prob for DNA fragment analysis, southern blot and hybridization, prob preparation for RNA analysis, Northern blot.

**Recommended Books:**

1. Primose (2001) 5th edition, “Principles of Gene Manipulation” Blackwell Science.
2. Lodish (2002) 4th edition, “Molecular Cell Biology” W.H Freeman & company.
3. Brucr Albert (2002) 4th edition, “ Molecular Biology of the Cell” Garland science.
4. James D, Watson (2003) 5th edition, “Molecular Biology of the Genes” W.H Freeman and Company.
5. Brown T (2000) 2nd edition, “Introduction to Gene Cloning” McGraw Hill Inc.
6. Anil K (2001) 1st edition, “Textbook of biotechnology” S Chand Series.
7. Agarwakl K (1999) 2nd edition, “Molecular Biology and Biotechnology” S Chand Series.

**MEDICAL BIOTECHNOLOGY**

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| **BT-324 (3 Credit hours)**  |

**Course Contents:**

# Cancer. Carcinogenic viruses. Gene therapy; classical gene therapy, non-classical gene therapy, different diseases for which gene therapy is successful. Molecular Diagnostics. DNA mutation scanning. Monoclonal antibodies; cloning monoclonal antibodies, uses of monoclonal antibodies. Recombinant DNA Vaccines. Interferon; cloning interferon, types of interferon, engineering interferon, therapeutic use and mechanism of action of interferon. Engineering human growth hormone. Enzymes therapy; DNase 1, alignate lyase.

# Recommended Books

1. Glick B, Pasternak J (2004) 3rd edition, “Molecular Biotechnology” Willey and Sons.
2. Strachan S, Andrew P (2004) 3rd edition, “Human Molecular Genetics” Willey and Sons.
3. Lewin C, Benjamin M (2002) 7th edition, “Gene 7” Oxford Univ. Press.

**TECHNIQUES IN BIOTECHNOLOGY-I**

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| **BT-325 (3 Credit hours)**  |

**Course Contents: Course Contents:**

Ultra centrifugation, Sedimentation, density gradient and differential centrifugation, Introduction to Chromatography, types of chromatography, HPLC instrumentation and applications., Electrophoresis, paper and gel Electrophoresis, Capillary and two dimensional electrophoresis, PCR, blotting techniques.

**Recommended Books:**

1. Campbell L, Durek, Braun B (1987) 1st edition, “Introduction to instrumental Analysis” Mc Graw Hill International editions, chemistry series.
2. Kenkel J (1994) 2nd edition, “Analytical Chemistry for Technicians” Lewis Publishers, BocaRaton.
3. Wilson K, Walker J (1994) 3rd edition, “Principles and Techniques of Practical Biochemistry” Cambridge University Press. Cambridge.

**BIOINFORMATICS-II**

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| **BT-326 (3 Credit hours)**  |

**Course contents:**

Structural Bioinformatics: Structural Biology Database (Protein Data Bank PDB, Structural classification of Proteins (SCOP), CATH databases). Structure Prediction: Homology modeling, Protein fold recognition, Ab-intio Protein structure prediction, Predicting transmembrane protein domain. Molecular Modeling and Visualization: DS Viewer, Swiss PDB viewer, Rasmol. Applications of structural Bioinformatics and Structural Genomics: Medical Infomatics ( Telemedicine, Medical records, Reports, image and their management, Medical databases and Networks).

Recommended Books:

* 1. Stephan M. and Stephen A. Krawetz (2000), Bioinformatics: Methods and Protocols, Humana Press Totowa, New Jersey.
	2. Westhead D.R., Parish J.H. and Twyman R.M (2003), The instant Notes series: Bioinformatics. Ist edition, BIOS Scientific Publishers Limited, Oxford, UK.
	3. D. Higgins, W. Taylor (2001), Bioinformatics: Sequence, structure and databanks. A practical approach, Oxford University press.
	4. Andrew R. Leach (2003), Molecular Modeling, Principles and applications. Addisin Wesley Longman Limited.
	5. Claverie, J.M and Cedric Notredame (2003), Bioinformatics-A. Beginners Guide, Wiley publishing, Inc, USA.
	6. Subramanian C (2004), A textbook of Bioinformatics. Dominant Publishers and Distributors New.
	7. Gibas. C and Jambeck. P (2001), Developing Bioinformatics Computer Skills. Published by O’Reilly & Associates, Inc. USA.
	8. Bouxivanous: Structural Bioinformatics

**FOURTH YEAR**

**Semester VII**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 411 | Genomics  | 3 |
| BT- 412 | Oncology | 3 |
| BT- 413 | Techniques in Biotechnology-II | 3 |
| BT- 414 | Proteomics | 3 |
| BT-415ORBT-416 | Economics and Business Applications in BiotechnologyORBioethics | 2 |
| BT-417 | General-IV (Research Methodology ) | 3 |
| **Seventh Semester Total** | **17** |

**Semester VIII**

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| **Course No.** | **Course Title** | **Cr. Hours** |
| BT- 421 | Food Biotechnology | 3 |
| BT- 422 | Pharm. Biotechnology | 3 |
| BT- 423 | Biochemical Engineering  | 3 |
| BT- 485 | Two optional /Thesis | 4 |
| BT-424 | Industrial Biotechnology | 3 |
| BT-425 | Biostatistics  | 2 |
| **Eighth Semester Total** | **18** |

**THESIS OR TWO OPTIONAL COURSES**

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| **COURSE NO** | **OPTIONAL COURSE** | **Cr. Hours** |
| Biotech: 485-1 | Current Trends in Molecular Biology | 3 |
| Biotech: 485-2 | Medical Genetics | 3 |
| Biotech: 485-3 | Molecular Medicine and Drug Development  | 3 |
| Biotech: 485-4 | Protein Structure/ Protein Engineering  | 3 |
| Biotech: 485-5 | Stem Cell and Therapeutic Cloning | 3 |
| Biotech: 485-6 | Agriculture Biotechnology | 3 |
| Biotech: 485-7 | Biopolymers | 3 |
| Biotech: 485-8 | Isolation Of Natural Products From Plants | 3 |
| Biotech: 485-9 | Infectious Diseases | 3 |

**SEMSETER VII**

**GENOMICS**

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| **BT-411 (3 Credit hours)**  |

**Course contents:**

An overview of genomics; what is genome and genomics, History of genomics, Applictions of genomics. The ‘ome and –omics series. Genomes: Prokaryotic genome (E.coli genome), Eukaryotic genome (Human Nuclear and Mitochondrial genome), Extra chromosomal genome (Mitochondrial and Chloroplast genome). Genome sequencing projects; genome mapping, genomic sequencing, genome projects (Human, Drosophila, Caenorhabditis elegans), finding genes, gene assignment, bioinformatics in genome. Post genome analysis; global changes in gene expression, differential display, microarrays, chips with everything, protein function on a genome wide scale, Knock out analysis, anti-sense and RNA interference (RNAi), Genome- wide Two-hybrid screens, protein detection arrays. Methods in genomics; Methods of gene sequencing, Gene prediction and gene counting, genome similarity and SNPs, DNA chips (DNA microarray) technology and its applications. Types of Genomics; Structural genomics, Functional genomics, Comparative genomics and Mutational genomics. Applications of genomics in Biomedical Research: Genomics impact on medicine and New molecular medicine, individual response to drugs (Pharamacogenomics), Genomics impact on cancer research, Taxicogenomics.

**ONCOLOGY**

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| **BT-412 (3 Credit hours)**  |

**Course contents:**

**Cancer Biology: The Basics**

Introduction, historical perspective, classification, carcinogenesis, Cancer initiation, promotion and progression. Cellular proto-oncogenes, oncogenes activation. Growth factors, growth factor receptor, signal transduction. Retroviral oncogenes.

**Cancer genes II: Tumor suppressor genes and cell cycle regulation**

Tumor suppressor genes, Cancer cell cycles. DNA viruses/ cell immortalization, Tumor suppressor genes pathways, DNA methylation, epigenetic silencing of suppressor genes, Genomic instability, Apoptosis.

**Understanding Cancer as a disease: Natural history of cancer development**

Free radicals, antioxidant and cancer metabolic oxidative stress. Cancer gene rearrangement, detecting, oncogenes abnormalities in clinical specimens. Cell: cell interaction, cell adhesions, angiogenesis, invasion and metastasis.

**Current Concept in Cancer therapy**

Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy, Cancer immunity and strategies of anticancer immunotherapy.

**Recommended Books**

1. Robert A ‘The biology of Cancer’ 2nd edition, 2001, Garlands Publishers
2. Dennis W. Ross, ‘Introduction to oncogen and Molecular Cancer’ 2nd edition, 2003, Springer Publishing Company
3. Geoffry M Cooper, ‘Oncogens’ 2nd edition, Jones and Bretlett Publishers
4. Glick A, Pasternack N, ‘Molecular Biotechnology’ 3rd edition, 2005.

**TECHNIQUES IN BIOTECHNOLOGY-II**

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| **BT-413 (3 Credit hours)**  |

 **Course contents:**

**Theory, instrumentation and application of:**

1. UV-Visible spectroscopy
2. Infra red Spectroscopy
3. Nuclear Magnetic Resonance spectroscopy
4. GC-Mass spectrometry
5. Atomic absorption Spectrometry

**Recommended Books**

1. Campbell L, Durek D. Barun B (1987) 1st edition, ‘Introduction to instrumental Analysis’ Mc Graw Hill International editions, Chemistry Series.
2. Kenkel J (1994) 2nd edition, ‘Analytical Chemistry for technicians’ Lewis Publishers, Bocaraton.
3. Wilson K, Walker J (1994) 3rd edition, ‘Principle and techniques of Practical Biochemistry’ Cambridge University Press, Cambridge.

**PROTEOMICS**

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| **BT-414 (3 Credit hours)**  |

**Course Contents:**

 Introduction to proteomics. Bridging genomics and proteomics. Methods of measurement of gene (mRNA expression). DNA array hybridization and non DNA array based method of mRNA quantification. Brief introduction to techniques used in proteomics. Image analysis of two-dimensional gel, data acquisition, digital image processing, Protein spot detection, gel matching, data analysis, data presentation, database. The automation of proteomics-technical solution, informatics solution for proteomics. The scope of functional proteomics;

1. Drug development and toxicology
2. Phage antibodies as tools for proteomics
3. Glycobiology and proteomics
4. Proteomics in plant genetics and breeding.

**Recommended Book:**

1. S. R. Pennington, M. J. Dunn, ‘Proteomics’ 1st edition, 2002, BIOS scientific Publishers Limited.

**ECONOMICS AND BUSSINESS APPLICATIONS IN BIOTECHNOLOGY**

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| **BT-415 (2 Credit hours)**  |

**Course Contents:**

Multinational Corporation and biotech. Biotech economics. Competition and market;macroeconomics, linkage to biotech, marketing biotech commodities.

Biotechnology market regulations;patents and patenting biotechnology inventions, intellectual property rights, plants variety protection act, animal variety protection act.

**Recommended Books:**

1. Tom A (2003) 1st edition, “The Biotech Investor” USA.
2. Cynthia R (2001) 1st edition, “The Business of Biotechnology” USA.

**BIOETHICS**

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| **BT-416 (2 Credit hours)**  |

**Course Contents:**

Introduction to bioethics. Commercialization and benefit sharing of biotechnology. Human genome project. Ethical and legal aspect of biotechnology. Optimizing safety and benefits of genetic testing; a look at Canadian policy. Experimentations on human embryos; bioethical discussion in Europe with special attention to Austria and Germany. The cultural challenge of biotechnology in post communist Europe. This gene is different from other; the Jewish approach to biotechnology. Islamic perspective on biotechnology. Research ethics; an East Asian perspective. Media biotechnology and culture. Bioterrorism and justice. Policy statements and case study.

**Recommended Books**:

1. Reddy L (2002), 1st edition, “Bioterrorism” APH Publishing Corporation, New Delhi.
2. Helga K, Petter S (2001) 1st edition, “A Companion to Bioethics” Blackwell Publishing Corporation USA.
3. Michaecal C (2000) 1st edition, “Cross Culture Biotechnology” Rowman and Littlefield Publishers INC.

**GENERAL-IV (RESEARCH METHODOLOGY)**

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| **BT-417** **(3 Credit hours)** |

**Course Contents:**

Overview of scientific research. Improvement through research, nature of scientific inquiry, applications of research in industry. Choosing a project; development of a research project, writing a research grant application, role of students, supervisor’s role. Designing and investigation; identifying the level within investigation, deciding on techniques to be employed. Analysis of results; control, samples and replications. Reviewing the literature; primary and secondary sources, scientific record keeping. Use of microorganisms, animals, plants and humans in experimentation. Use of pathogens in experiments. Conflict of interests. Ownership of data; writing, presentation and publishing the scientific papers, filing patent application.

**SEMESTER VIII**

**FOOD BIOTECHNOLOGY**

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| **BT-421 (3 Credit hours)**  |

 **Course Contents:**

Food sciences; food technology, food nutrition and food biotechnology. Food additives, food borne diseases, enzymatic reactions, Principle of food preservation by heating/canning, Principle of food preservation by drying/dehydration, Principle of food preservation by refrigeration/gas refrigeration. Principle of food preservation by freezing, Principle of food preservation by food concentrates, Principle of food preservation by fermentation, Principle of food preservation by pickling and curing.

 **Practicals:**

Visits to industry, Milk and milk products. Plain and flavored yogurt, Cheese preparation. Ethanol production, biomass production. Production of organic acids; Vinegar, citric acid, lactic acid etc. Fruits and vegetables; fermented vegetables, pectin production and enzymatic activity in juices, Cereal products, plain and sour bread studies, preservation techniques. Meat and egg products, seafood.

**Recommended Books**

1. John T, Nickerson L, Louis J (2002), 2nd edition, ‘Elementary food sciences, National book foundation
2. Norman D (2002) 4th edition, ‘The technology of food preservation’ National book foundation.

**PHARMACEUTICAL BIOTECHNOLOGY**

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| **BT-422 (3 Credit hours)**  |

**Course contents**

Introduction to concepts and technologies in pharmaceutical biotechnology, Polymer, classification, polymerization and characterization of polymer, different averages molecular weight, controlled drug release, its advantages and disadvantages over conventional release, non-toxicity, biodegradability and biocompatibility in drug release, solvent, diffusion and chemically controlled drug release system. Hydrogels, Microbial transformation: types of reactions mediated by microorganisms i.e. antibiotics and itaconic acid. Regulatory issues like biosafety and intellectual property right and protection in biotechnology.

**Recommended books**

1. A.R. Arnold, ‘Pharmaceutical biotechnology’ 3rd edition, 2002, oxford publishers.
2. Lachman, ‘Theory and practice in industrial pharmacy’ 3rd edition, Lea and Febiger, Philadephi (1986)
3. Cooper and Gunn, ‘Tutorial Pharmacy’ 6th edition, 1999, Pitman Medical Pub.Co.Ltd, England
4. **Kayser O, Muller H (2004) “Pharmaceutical biotechnology” 1st edition, willy-vch.**

**BIOCHEMICAL ENGINEERING**

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| **BT-423 (3 Credit hours)**  |

**Course Contents:**

Principles of chemical engineering. Units and subuits. Materials and energy balances and thermodynamics; different types of heat of reactions; industrial processes flow diagrams; survey of industrial processes flow diagrams; survey of unit processes, and flow diagrams. Chemical and biochemical reactors. Instrumentation control. Selected processes in downstream processing; novel bioreactor systems.

## Practicals:

Working with Fermenter, extraction unit. Centrifuge, evaporators, spray dryer, separation of solid particles: Cross-flow filtration, Determination of the ‘Disruption Constant’ with a Bead Mill, Optimization of the disruption of Saccharomyces cerevisiae using a high-pressure homogenizer, precipitation of proteins from a crude yeast extract by Ammonium sulphate, separation of the enzymes Glucose-6-phosphate Dehydrogenase and Fumarase by Ion Exchange Chromatography. Isolation of Actinomycin D as an example for obtaining secondary metabolites.

**Recommended Books:**

1. Robert H (1997) 7th edition, “Pery’s Chemical Engineers Hand Book” Mc Graw Hill Company.
2. Little J (2000) 1st edition, “Principles of Chemical Engg” Willey & Sons.
3. John-Perry (2001) 1st edition, “Chemical Engineering Handbook” Willey & Sons.
4. Richardson C (2002) 3rd edition, “Chemical Engineering” Wiley & Sons.

**INDUSTRIAL BIOTECHNOLOGY**

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| **BT-424 (3 Credit hours)**  |

**Course Contents:**

Introduction to industrial biotechnology; historical landmarks, application of industrial biotechnology, biosafety and regulation during industrial production, code of good manufacturing practice (GMP). Features of biotechnological important microorganisms; commonly used microbes in industries, culture of microorganism, isolation and screening of microorganism, maintenance of isolates, inoculum development, strain improvement, production of whole cells, brief description of low and high molecular weight, compounds. Fermenters and Process Development; introduction to fermenter (bioreactor), types of fermenter, fluidized bed bioreactor, loop or air fill bioreactor, membrane bioreactor, bubble column bioreactor, photo bioreactor and stirred tank bioreactor. Construction of bioreactor; design and operation, achievement and maintenance of aseptic conditions and scale up of fermentations. Process development.

Down Stream Processing; introduction, separation of particles, disintegration of cells, extraction, concentration, purification and drying, in-situ recovery of products. Special Fermentation and Microbial Biotechnology; alcoholic, lactic acid, acetic acid fermentation, production of organic acids by fungi like oxalic acid and citric acid. Industrially important products; antibiotics, amino acids, enzymes, vitamins and toxins. Single cell Protein (SCP) and Mycoproteins; introduction advantage of producing microbial protein, microorganisms used, substrates, nutritional value of SCP, genetic improvement in microbial cell, production of algal biomass, production of yeast biomass. Enzymes engineering; introduction, objectives, principles, general steps in enzyme engineering and limitations. Large scale production of protein from recombinant microorganisms; vaccines, hormones, antibodies. Synthesis of commercial products by recombinant microorganisms; restriction endonuclease, small biological molecules and biopolymers.

**Practicals:**

Determination of growth curve of bacteria. Study of fermentation by using yeast

Study of acetic acid oxidation (Vinegar Production) in laboratory. Wine production by using grape juice. Demonstration of yogurt production by using bacteria. Bioassay of vitamin B12 (Cyanocobalamine). Demonstration of antibiotic production

Demonstration of enzymes production. Large-scale growth of bacteria and determination of wet weight and dry weight. Measurement of fungal growth by biomass (mycelial dry weight) method.

**Recommended Books:**

1. Dubey R and Maheshwari D (2002) 2nd edition, “Text book of Microbiology” S. Chand Series.
2. Glick B, Pasternak J (2004) 3rd edition, “Molecular biotechnology” Willey and Sons.

**BIOSTATISTICS**

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| **BT-425 (3 Credit hours)**  |

**Course Contents:**

Basic statistics for biotechnology. Measure of central tendency, Co-efficient of variance. Probability. Distribution, normal binomial and Poisson’s distribution. Hypothesis testing; one and two sample hypothesis, z-and other tests. Simple linear regression. Analysis of variance, Non-parametric tests, Distribution free tests, Chi-square tests.

Recommended Books:

1. Anthony N (1995) 1st edition, “High Yield Biostatistics” William & Wilkins Company.
2. Glover D, Mitchell S (2002) 2nd edition, “An Introduction to Biostatistics” McGraw Hill Companies.

**THESIS OR TWO OPTIONAL COURSES:**

**CURRENT TRENDS IN MOLCULAR BIOLOGY**

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| **Biotech-485-1 (3 Credit hours)**  |

**MEDICAL GENETICS**

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| **Biotech-485-2 (3 Credit hours)**  |

**Course Contents:**

Basic principles of human genetics, chromosomal disorder. Modes of inheritance and gene disorder. Biochemical genetics. Hemoglobin disorder. Immunogenetics. Genetics of cancer. Genetic counseling. Prenatal diagnosis and treatment of genetic diseases.

**Recommended Books:**

1. Pal G (2003) “Medical Genetics” 1st edition, AITS Publication and Distributors.

**MOLECULAR MEDICINE AND DRUG DEVELOPMENT**

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| **Biotech-485-3 (3 Credit hours)**  |

**Course Contents:**

Different methodologies for designing new medicine and drugs. Combinatorial drug development. Enzymes synthetic template for drug development. DNA binding drugs, RNA binding drugs. Design of inhibitor. Targeted delivery of drugs. Microbial models for drugs metabolism. Enzyme inhibition studies.

**Recommended Books:**

1. **Kayser O, Muller H (2004) “Pharmaceutical biotechnology” 1st edition, willy-vch.**

**PROTIEN STRUCTURE/ PROTIEN ENGINEERING**

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| **Biotech-485-4 (3 Credit hours)**  |

**Course Contents:**

Introduction to protein engineering, introduction to protein structure, protein conformation, protein sequencing, predicting protein conformation from sequence data. Methods of protein 3D structure determination, protein isolation, purification modification and characterization. Extraction of proteins from plant tissues, animal tissues, bacteria, fungi etc. Extraction of recombinant proteins from bacteria. Extraction of membrane proteins. Lyophilization of proteins and storage of pure proteins. Expression of protein in bacteria. Expression of protein in yeast, expression of engineered protein in mammalian cell culture, insect cell expression technology. Mutational effect on protein folding on an industrial scale. Protein engineering for stability, structure function relationship for protein design. Bacteriophage display libraries. Design of metalloproteins. Engineering therapeutic antibodies. Site directed mutagenesis, site directed drug designing.

**Recommended Books:**

1. Glick B, Pasternak J, (2004) “Molecular Biotechnology” 3rd edition, ASM Press.

**STEM CELL AND THERAPEUTIC CLONING**

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| **Biotech-485-5 (3 Credit hours)**  |

# Course Contents:

An introduction to early animal development, characteristics of cell types and stages of

 differentiation, lineage tracing, De-differentiation, stem cells, types, embryonic stem cells (ICM), fetal stem cells, adult stem cells (brain, bone marrow, blood, skeletal muscles and skin),properties of stem cells, techniques for manipulating stem cells, potential uses and applications, tissue engineering ,tissue creation , tissue replacement therapies , organ creation, cloning types, techniques, combination of cloning techniques with embryonic stem cells, therapeutic cloning ,potential uses and applications.

 **Books recommended:**

1. Fred H, Wili W (2004) “Principles of Developmental Biology” 1st edition, W Norton Company New York
2. Butter H (1994) “Invitro Cultivation of Animal Cells” Greenwich pub. Great Britain.

**AGRICULTURE BIOTECHNOLOGY**

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| **Biotech-485-6 (3 Credit hours)**  |

**Course Contents:**

Plant cell cultures for the production of secondary metabolites, hairy root culture, elicitation of product accumulation, biological control on the production of secondary metabolites. Genetic Engineering of nitrogen fixation, nif- gene transfer, detailed mechanism of nodule formation by bacterium. Problems in Nif gene transfer. Biotic stress resistance; insect resistance, viral resistance, fungal resistance. Development of sencence. Abiotic stress resistance, herbicides resistance. Bioinsecticides; bacteria, viruses. Genetic engineering of plants.

**Recommended Books:**

1. Glick B, Pasternak J, (2004) “Molecular Biotechnology” 3rd edition, ASM Press.
2. Watson B, Gann B, Levine L (2003) “Molecular Biology of the Gene” 5th edition, Pearson Education Companies.

**BIOPLYMERS**

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| **Biotech-485-7 (3 Credit hours)**  |

**ISOLATION OF NATURAL PRODUCTS FROM PLANTS**

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| **Biotech-485-8 (3 Credit hours)**  |

**INFECTIOUS DISEASES**

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| **Biotech-485-9 (3 Credit hours)**  |