DEPARTMENT OF PLANT BIOLOGY & BIOTECHNOLOGY

M.Sc. - BIOTECHNOLOGY

SYLLABUS

Effective from the Academic Year 2016-2017

LOYOLA COLLEGE (Autonomous)

Ranked 2 in INDIA RANKING 2017 - NIRF
'College of Excellence' Status Conferred by UGC in 2014
Re-accredited with 'A' Grade (3.70 CGPA) by NAAC in 2013
Chennai - 600 034

RESTRUCTURING-2016 (2016-17 batch ONWARDS)
PG - Arts / Science / Commerce / Social Work

Part	Semester 1	Semester 2	Summer Vacation	Semester 3	Semester 4	Total Hours
Major Core (MC)	30(20 C)	24(20 C)	– –	20(15 C)	30(24 C)	104(79 C)
Elective Subject (ES)	– –	4(3 C)	– –	4(3 C)	– –	8(6 C)
Inter - Disciplinary (ID)	– –	– –	– –	6(5 C)	– –	6(5 C)
Self study Paper (SSP)				Outside class hours(2C)		(2 C)
Summer Training Program (STP)	– –	– –	3 to 4 weeks (1 C)	– –	– –	(1 C)
Life Skills Training (LST)	– –	2h + 2h# (2 C)	– –	– –	– –	2+2# (2 C)
Extension Activities	LEAP	LEAP(3 C)	– –	– –	– –	(3 C)
Total Hours (Total Credits)	30 (20 C)	30+2# (23+5 C)	–(1 C)	30 (23+2 C)	30 (24 C)	120+2# (90+6+2*)C

Note: A theory paper shall have 5 to 6 contact hours and a practical session shall have 3 to 5 contact hours.

New format of the subject codes from the 2016 regulation

Subject codes are 10 characters long:

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th

- 1st & 2nd digits – last two digits of regulation year in YY format (If 2016, it will be 16).
- 3rd alphabet: U – UG / P – PG / M – M.Phil. / D – Ph.D.
- 4th & 5th alphabets : department wise program code(example – MT / CO / HT…..)
- 6th digit: Semester for UG/ PG / M.Phil. and year for Ph.D.
- 7th & 8th alphabet: Category of paper or group of category of papers (GE/RL/OL/HE/OR/AL /ES/SK/MS/CM/CC/ ……)
- 8th & 9th digits: subject number range (01 to 99).

For example,

Example 1:16UCH1MC01

16 – Admitted in 2016
U – UG student
CH – Chemistry Student
1 – 1st Semester subject
MC01 – Major paper

Example 2:16PCO2ID01

16 – Admitted in 2016
P – PG student
CO – Commerce Student
2 – 2nd Semester subject
ID01 – Inter disciplinary paper

- For subjects which are carried forward from one regulation to the next, the first two digits representing the regulation alone will change.
- Subjects which are not carried forward from one regulation to the next, will not appear in the new regulation.
- For new subjects which need to be added to a regulation, a new subject code must be created in continuation of the last created code under that type/category.
- Subject codes which are identical (except for the first two digits which represent the regulation year) are treated as equivalent for the purpose of syllabus / question paper setting / conducting examination / etc.

M.Sc., BIOTECHNOLOGY - RESTRUCTURED TEMPLATE 2016

S. No	Subject Code	SUBJECT TITLE
1	16PBT1MC01	CELL AND DEVELOPMENTAL BIOLOGY
2	16PBT1MC02	BIOCHEMISTRY
3	16PBT1MC03	MICROBIOLOGY
4	16PBT1MC04	IMMUNOLOGY
5	16PBT1MC05	LAB-I (CELL AND DEVELOPMENTAL BIOLOGY / BIOCHEMISTRY)
6	16PBT1MC06	LAB-II (MICROBIOLOGY / IMMUNOLOGY)
7	16PBT2MC01	MOLECULAR BIOLOGY AND GENETIC ENGINEERING
8	16PBT2MC02	FERMENTATION TECHNOLOGY
9	16PBT2MC03	ENVIRONMENTAL BIOTECHNOLOGY
10	16PBT2MC04	LAB-III (MOLECULAR BIOLOGY AND GENETIC ENGINEERING / FERMENTATION TECHNOLOGY / ENVIRONMENTAL BIOTECHNOLOGY)
11	16PBT2ES01	HUMAN GENETICS

12	16PBT2ES02	BIOANALYTICAL TECHNIQUES
13	16PHE2FC01	LIFE SKILLS TRAINING
14	16PBT3MC01	OUT REACH
15	16PBT3MC01	ANIMAL BIOTECHNOLOGY
16	16PBT3MC02	PLANT BIOTECHNOLOGY
17	16PBT3MC03	RESEARCH METHODOLOGY AND BIOINFORMATICS
18	16PBT3MC04	LAB-IV (ANIMAL BIOTECHNOLOGY / PLANT BIOTECHNOLOGY)
19	16PBT3ES01	NANOTECHNOLOGY
21	16PBT3ES02	CANCER BIOLOGY
20	16PBT3ID01	PRINCIPLES OF FOOD PROCESSING
22	16PBT3TP01	SUMMER TRAINING PROGRAMME
15	16PBT4PJ01	PROJECT

16PBT1MC01 CELL AND DEVELOPMENTAL BIOLOGY

SEMESTER I **CREDITS 4**
CATEGORY MC(T) **NO.OF HOURS/ WEEK 5**

Objectives:

1. To provide a basic understanding of the structure and function of cellular organelles and the functional interaction of the cell with its microenvironment.
2. To introduce students to the developmental processes that lead to the establishment of the body plan of vertebrates and the corresponding cellular and genetic mechanisms.

UNIT 1 - Cellular organization (1+12+2)

1. Cell structure – prokaryotes and eukaryotes. Visualization of cells using Light microscopy and Electron microscopy.
2. Plasma Membrane – Structure, Organization and dynamics of transport across membrane; Mechanism of endocytosis and exocytosis.
3. Cytoskeleton – Microfilaments – Structural organization, cell motility and cell shape; Microtubule: Cilia, flagella, centriole; Intermediate filaments.
4. Mitochondria – Structure, organization of respiratory chain complexes, ATP synthase, Mitochondrial DNA.
5. Chloroplast – Structure and functions, Chloroplast DNA and its significance.
6. Lysosome - Formation and functions - Autophagy, Heterophagy.
7. Nucleus- Structure and function of nuclear envelope, lamina and nucleolus
8. Cell division and cell cycle – Mitosis and meiosis, their regulation, steps in cell cycle, control of cell cycle and cell death.

Unit 2 - Cell-cell interactions (1+12+2)

1. Cell adhesion molecules; Cellular junctions - gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

2. Signal transduction - Intracellular receptor and cell surface receptors - Signaling via G-protein coupled receptors (PKA, PKC, and CaM kinase) - Ras to MAPK pathway (Insulin receptor signaling), JAK - STAT pathway (EPO signaling).
3. Bacterial signaling systems, bacterial chemotaxis and quorum sensing and plant two componenet sensing.

Unit 3 - Basic concepts of development (1+12+2)

1. Potency, commitment, specification, induction, competence, determination and differentiation - morphogenetic gradients - cell fate and cell lineages; stem cells - genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
2. Oogenesis and Spermatogenesis, Fertilization; embryo sac development, zygote formation, cleavage, blastula formation, gastrulation in Humans.

Unit 4: Body pattern formation & organogenesis (1+12+2)

1. Origin of anterior-posterior and dorsal-ventral polarity in *Drosophila* - Role of maternal, segmentation and homeotic genes.
2. Organization of HOX gene in vertebrates. Axis formation in Amphibians - Nieuwkoop Centre and Primary organizer.
3. Axis formation in birds and mammals: Involvement of pattern forming genes.
4. Organogenesis – vulva formation in *Caenorhabditis elegans* - eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons.
5. Determination of sexual phenotype: Primary sex determining genes in Y chromosome, gonadal hormones, sex determination in *Drosophila*, Sex determination in *C. elegans*, Dosage compensation in X linked genes.

Unit 5: Plant developmental biology (1+12+2)

1. Introduction of model plants used for development studies, *Acetabularia* –Life cycle.
2. Arabidopsis reproduction - Male and female gametophyte development, genetic and hormonal regulation of reproduction.
3. Basic layout of dicot and monocot embryos, cell division and pattern formation in embryo, genetic and hormonal regulation of embryo development. Seed formation - cotyledon, endosperm and seed coat development.
4. Shoot development - Structure and function of shoot apical meristem (SAM), initiation and maintenance of SAM. Root development - Root apical meristem structure and function, lateral root development, adventitious root development.
5. Flower development: Transition from vegetative to reproductive stage, inflorescence meristem, floral whorls specification.

Books for Study:

1. Gilbert S.F., 2003. Development Biology, 7th edition. Sunderland, Sinaure Associates Inc.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon, Kelsey Marti, 2016. Molecular Cell Biology, 4thedition, W.H. Freeman & Company.
3. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E, Smith J, 2007. Principles of Development, 3rd edition, London - Oxford university press.

Books for Reference:

1. Becker MW, Kleinsmith LJ and Hardin J. 2007. The World of the Cell, 6th Edition, Tata McGraw Hill Publications.

2. Karp G. 1998. Cell and Molecular Biology, 2nd edition, John Wiley and Sons, Inc.
3. Lodish H, Berk A, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey Martin, 2016. Molecular Cell Biology, 8th Edition, W.H. Freeman and Company, New York.
4. Raven PH, Johnson GB, Losos JB and Singer SR.2006. Biology, 7th Edition, Tata McGraw Hill Publications.
5. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, 2007. Cell Biology, 2nd Edition, Saunders.
6. Werner A Mueller, 2012. Developmental Biology, Springer.

16PBT1MC02 BIOCHEMISTRY

SEMESTER I **CREDITS 4**
CATEGORY MC(T) **NO.OF HOURS/ WEEK 5**

Objectives:

1. To understand the importance of the biomolecules present in our system and the metabolic pathways.
2. To analyze the biophysical methods and applied it to study the biomolecules.

Unit 1: Foundations of biochemistry (1+12+2)

1. Water – structure, physical properties- water as solvent , osmosis and diffusion, Hydrophobic effect, Chemical properties of water – Ionization of water- pH scale, pH measurements, pH maintenance, pK, Acid-base balance – Buffers- Henderson- Hasselbalch equation and action of biological buffers.
2. Functional groups in biomolecules. Molecular asymmetry – stereoisomers.
3. Laws of Thermodynamics.

Unit 2: Structure and classification of biomolecules(1+12+2)

1. Classification of Carbohydrates – Structure and biological functions of mono saccharides,

oligosaccharides and polysaccharides- Cellulose, Chitin, Starch , Glycogen, Glycosaminoglycans, Proteoglycans.

2. Lipids Classification –structure of fatty acids, TAGs, sphingolipids, phospholipids, glycerolipids, gangliosides, glycolipids and cholesterol.
3. Classification of amino acids, nonstandard amino acids.
4. Structural hierarchy of proteins-Forces stabilizing protein structure
5. General approach for protein purification-Chromatography and electrophoresis of proteins.

Unit 3: Metabolism I (1+12+2)

1. Photosynthesis-Light reaction and dark reactions.
2. High-energy phosphate compounds: introduction, phosphate group transfers. Oxidation-Reduction Reactions -NAD+ and FAD+ Oxidation-Reduction Reactions -NAD+ and FAD, The Nernst Equation.
3. Glycolysis, TCA cycle, Gluconeogenesis.
4. Electron transport chain and oxidative phosphorylation.

Unit 4: Metabolism II (1+12+2)

1. Synthesis of fatty acids, β-oxidation of fatty acids – carnitine shuttle, Cholesterol metabolism.
2. Protein synthesis -Protein degradation, Amino acid transamination and deamination reactions.
3. Metabolism of purines and pyrimidines.

Unit 5: Enzymology (1+12+2)

1. General properties of Enzymes-Enzyme nomenclature - Substrate specificity, Cofactors and Coenzymes, Activation energy and the Reaction coordinate.
2. Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency.
3. Enzyme characterization and Michaelis - Menten kinetics - Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification - Single substrate enzyme.

4. Enzyme inhibition - Competitive inhibition, Uncompetitive inhibition, Mixed inhibition

Books for Study:

1. Voet, V and J.G.Voet, 2010. Biochemistry, 4th edition, John Wiley & Sons, New York.
2. Moran, L. A, Horton R.A, Scrimgeour G., Marc Perry and David Rawn, 2013. Principles of Biochemistry 5thedition, Pearson Education Ltd.
3. Nelson, L.D. and M.M Cox, 2008. Lehninger's Principles of Biochemistry, Macmillan, Worth Publication Inc.
4. Wilson and Walker.J, 2010. Principles and techniques of Practical Biochemistry. Cambridge University Press.

Books for Reference:

1. Berg J.M., TymoczkoJ.L. and Stryer.L.2007. Biochemistry, 7th edition, W.H.Freeman and Company, New York.
2. Cotterill. R, 2003.Biophysics: An Introduction. John Wiley & Sons.
3. Deb.A.C. 2006. Concepts of Biochemistry (Theory and Practical). Books and Allied (P) Ltd., Kolkata.

Websites:

1. http://www.una.edu/faculty/aecrews/Biochemistry/LectureNotes.htm
2. http://chemistry.about.com/od/lecturenoteslab1/Biochemistry_Lecture_Notes_Labs.htm

16PBT1MC03 MICROBIOLOGY

SEMESTER I **CREDITS 3**
CATEGORY MC(T) **NO.OF HOURS/ WEEK 5**

Objectives

1. To understand the basic biology of microorganisms, including microbial anatomy, physiology, growth, genetics, and metabolism.

2. To recognize microbes as etiologic agents of disease, their mechanisms of pathogenicity, modes of spread, sensitivity to chemotherapy and resistance to some antimicrobial agents.

Unit 1: Microbial Diversity & Systematics (1+12+2)

1. Definition, scope and history of microbiology, Classical and modern methods and concepts; Spontaneous generation (abiogenesis), Biogenesis, Germ Theory of Disease, Koch's Postulates.
2. Classification of microorganisms and nomenclature - Haeckel's three kingdom concept, Whittaker's five kingdom concept. Classification and characterization of bacteria according to Bergey's Manual of Systematic Bacteriology.
3. Criteria for classification; taxometrics, serological methods, chemotaxonomy, phage typing.
4. Classification based on Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), and Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.
5. Microbes in extreme environment – Nature, special features of the thermophilic, methanogenic and halophilic Archaea - photosynthetic bacteria, Cyanobacteria.

Unit 2: Microbial Physiology (1+12+2)

1. Microscopy - Principles and applications of simple, compound, bright field, dark field, phase contrast, fluorescent and electron microbiology.
2. Microbial cell - Ultrastructure of bacteria, subcellular structures and cell envelope slime, capsule, cell wall, pili, flagella, cell inclusions, biosynthesis of bacterial cell wall, cell membrane.

3. Nutrition and growth of microorganisms - Nutritional types of microorganisms, nutritional requirements.
4. Physiology of growth - Significance of various phases of growth. Growth measurements - batch, continuous and synchronous
5. Factors influencing the growth of microorganisms – temperature, pH, Osmotic pressure, moisture, radiations and different chemicals.

Unit 3: Bacteriology (1+12+2)

Morphology, classification, cultural characteristics, pathogenicity, pathology, laboratory diagnosis and prevention – Control and treatment of diseases caused by the following organisms: Staphylococcus aureus, Streptococcus pyogenes, Streptococcus pneumoniae, Neisseria meningitides, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Salmonella typhi, Treponema pallidum.

Unit 4: Virology & Infectious agents (1+12+2)

1. General properties of viruses - Lytic and Lysogenic cycle of bacteriophages. Genome and lifecycle of Bacterial viruses - M13, lambda. Other infectious agents - viroids, satellite RNAs and virusoids, prions
2. Plant viruses - TMV, Cauliflower mosaic virus.
3. DNA Viruses - Poxviridae, Hepadnaviridae, Adenoviridae.
4. RNA Viruses - Picornaviridae, Orthomyxoviridae, Flaviviridae, Rhabdoviridae, Rotavirus, HIV and other Hepatitis viruses.

Unit 5: Mycology and Parasitology (1+12+2)

1. Classification of tung based on Morphology reproduction and site of infection. Fungi causing superficial mycoses – *Tinea nigra*, cutaneous mycoses – Trichophyton, Opportunistic mycosis – Candidiasis, Aspergillosis.
2. Life cycle, pathogenicity, laboratory diagnosis and treatment of *Plasmodium*.

Books for Study:

1. Alexander N. Glazer, Hiroshi Nikaido, 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology, Cambridge University Press.
2. David Greenwood, Richard C B Slack, Michael R. Barer, Will L Irving, 2012. Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and control, 18th edition, Elsevier.
3. Linda Sherwood, Joanne Willey, Christopher J. Woolverton, 2013.Prescott's Microbiology, 9th Edition, McGraw- Hill Edition.
4. Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller, 2015. Medical Microbiology, Elseiver.
5. Pelczar,1998.Microbiology, 5th edition, Tata McGraw-Hill Education
6. Schlegel. G, C. Zaborosch, M. Kogut, 2003.General Microbiology 7th Edition, Cambridge University Press.

Books for Reference:

1. Alexopoulus, C.J and C. W. Mims, 1993. Introductory Mycology. Wiley Eastern Ltd, New Delhi.
2. Brooks, G.F., S. Morse, K.C. Carroll, J.Butel, 2010. Jawetz, Melnick, and Adelberg's Medical Microbiology, McGraw Hill, New Delhi.
3. Davis, B.D., R. Delbecco., H.N. Eisen and H.S. Ginsburg, 1990. Microbiology, Harper & Row, New. York
4. Landecker, E.M., 1996. Fundamentals of the Fungi, Prentice Hall International, London.
5. Pelczar, M. J., E. C. S. Chan and N.R. Krieg, 2006. Microbiology, Tata McGraw Hill, New Delhi
6. Salle, A.J., 2001. Fundamentals & Principles of Bacteriology. McGraw-Hill, New Delhi.

Websites:

1. www.microbiologyonline.org.uk
2. www.adultlearn.com/resources/articles/microbiology
3. http://nhscience.lonestar.edu/biol/wellmeyer/lectures.htm
4. http://faculty.nwacc.edu/jstory/MicrobiologyHomePage.htm
5. http://www.accessexcellence.org/RC/VL/GG

16PBT1MC04 IMMUNOLOGY

SEMESTER I **CREDITS 3**
CATEGORY MC(T) **NO.OF HOURS/ WEEK 5**

Objectives:

1. To provide a deep insight on the multi various functions of the immune system in encountering pathogen, without harming the host.
2. To provide a basic understanding on the consequences of immune system failure, vaccines as preventive medicine, and various immunotechniques for the detection of the pathogen.

UNIT 1: Basic organization of the immune system (1+12+2)

1. Hematopoiesis; Cells and organs of the immune system.
2. Antigens, super antigens and haptens.
3. Immunity-Active, Passive; Structure, types and functions of antibodies; Innate and adaptive immune responses.
4. Immunological tolerance - Cellular and humoral immunity.
5. Cytokines - T-cell Receptor and activation - B-cell Receptor, activation and clonal selection - Antigen processing and presentation; Complement system.

UNIT 2: Immunogenetics (1+12+2)

1. Immunoglobulin genes - chromosomal location, structure and mechanism of gene rearrangements.
2. Major histocompatibility complex molecules - structure and function - MHC genes - MHC polymorphism,

Pattern of inheritance, HLA typing, MHC-disease associations.

UNIT 3: Clinical manifestations of immune dysfunction

(1+12+2)

1. Transplantation - types of transplantation, and rejection of grafts, prevention of graft rejection
2. Tumor immunology - tumor antigens, immune response to tumors and evasion of immune responses by tumors, cancer immunotherapy.
3. Immunodeficiency disorders – Primary and secondary immunodeficiency- ADA, SCID
4. Autoimmunity – systemic (SLE &Rheumatoid arthritis) and organ specific (Myasthenia Gravis & IDDM), induction and treatment
5. Hypersensitivity (I, II, III & IV) – types, induction and treatment.

UNIT 4: Vaccine and monoclonal antibody production

(1+12+2)

1. Vaccines - history, conventional vaccines, large-scale vaccine production - modes of administration, immune response to vaccines, use of adjuvants - recombinant vaccines (subunit, peptide, live attenuated and vector vaccines)
2. Current advances – DNA vaccines and issues in vaccine development for swine flu, bird flu, AIDS, cancer.
3. Hybridoma technology – History, methodology, characterization, purification and applications of monoclonal antibodies, humanized monoclonal antibodies.
4. Abzymes – definition, mode of catalysis and applications.

UNIT 5: Immunotechniques **(1+12+2)**

1. Immuno diffusion Agglutination tests, Immuno precipitation techniques

2. Enzyme-linked immunosorbent assay, Elispot assay, Radioimmunoassay, Western blotting.
3. Immuno screening of recombinant libraries, Solid -phase membrane immune bead assay (MIA); Epitope mapping
4. Immunohistochemistry – immunofluorescence, Immuno sensors.
5. Cell separation techniques -Magnetic sorting, FACS.

Books for Study:

1. Bona C. A., Bonilla F. A., 1996. Textbook of Immunology, Harwood Academic Publishers.
2. Brostoff .J, Seaddin J.K, Male D, Roitt IM, 2002, Clinical Immunology, 6th Edition, Gower Medical Publishing.
3. Charles A Janeway, Jr, Paul Travers, Mark Walport, and Mark J Shlomchik, 1999. Immunobiology, 4th Edition, Current Biology Publications.
4. Delves, P.J., S.J.Dennis, R. Burton, I. M. Roitt, 2011. Roitt's Essential Immunology, John Wiley and Sons, New York.
5. Kindt T. J., Goldsby R.A., Osborne B. A., Janis Kuby, 2002. Immunology, 6th Edition, Freeman.
6. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, 2011. Essential Immunology, 12th Edition, John Wiley publication.

Books for Reference:

1. Abul K. Abbas and Andrew H. Lichtman, 2001.Basic Immunology by, Saunders.
2. Charles Janeway and Paul Travers, 1999. Immunobiology: The Immune system in health and diseases, 4th Edition. Current Biology Publications.
3. Goding, 1985. Monoclonal antibodies, Academic Press.
4. William E Paul, 2012.Fundamental of Immunology, 7th edition, Lippencott Raven.

Websites:

1. www.immunology.org

2. www.aaaai.org
3. www.imat.cines.fr

16PBT1MC05 LAB-I
(Cell &Dev. Bio / Biochemistry)

SEMESTER I **CREDITS 3**
CATEGORY MC(L) **NO.OF HOURS/ WEEK 5**

Objectives:

1. The course aims to consolidate and extend basic knowledge of how cells work, how they interact and how they differentiate.
2. To help the learners to handle biochemical assays and procedures by exposing them to many analytical and separation techniques in biochemistry.

CELL & DEVELOPMENTAL BIOLOGY

1. Methyl Green –pyronin Y method for staining of DNA/RNA.
2. Mitosis using Onion root tips.
3. Meiosis using *Tradescantia spathacea.*
4. Isolation of Mitochondria and assay for cytochrome C oxidase.
5. Isolation of chloroplasts and quantification of chlorophyll.
6. Isolation of Barr bodies from buccal smear.
7. Study of chromosomal aberrations in onion root tip due to heavy metals.
8. Differentiation, Growth and morphogenesis in *Acetabularia* - Grafting experiment.
9. *D.discoideum growth on agar and maintenance.*
10. Model organism- Lifecycle of *A.thaliana*.

BIOCHEMISTRY

1. Buffers and buffering capacity – pKa of conjugate acids and bases
2. Qualitative Analysis of Carbohydrates.
3. Determination of total carbohydrates by Anthrone method.

4. TLC of sugars.
5. Qualitative Analysis of Amino acids.
6. Estimation of total free amino acids.
7. Estimation of Lysine.
8. Estimation of oil in oil seeds.
9. Estimation of protein by Folin Lowry method.
10. Estimation of protein by Bradford method.
11. Extraction and enzyme kinetics of Acid phosphatase from potato tubers.
12. Effect of pH on Acid Phosphatase.
13. Determination of Km of Acid phosphatases.
14. Partial purification of Bromelain.

16PBT1MC06 LAB-II (Microbiology/Immunology)

SEMESTER I CREDITS 3

CATEGORY MC(T) NO.OF HOURS/ WEEK 5

Objectives:

1. To provide hands on experience in microbiological and immunological techniques to students and will introduce them to experimentation, problem solving, data gathering, and scientific interpretation.
2. To provide a good foundation for research work in these areas.

MICROBIOLOGY

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Enumeration of bacteria from water sample – Viable plate count method
4. Isolation of pure culture – Streak plate method, spread plate method
5. Staining Techniques – Simple staining, negative staining Gram staining, spore staining, Acid fast Staining, Lacto phenol cotton blue staining for fungi
6. Motility test by Hanging drop method

7. Biochemical Characterization of Bacteria - Oxidation/Fermentation Test Catalase, Oxidase and Urease tests, IMViC tests, Hydrogen Sulfide Test and Nitrate Reduction Test, Casein and Starch Hydrolysis
8. Growth curve - measure of bacterial population by turbidometry
9. Evaluation of efficacy of Disinfectants- Rideal-Walker, Chick-Martin methods
10. Kirby Bauer Disc Diffusion test anti-microbial activity
11. Determination of Minimum Inhibitory and Minimum Bactericidal concentrations
12. Phage plating assay
13. Germ tube test for Candida.
14. Different stages of malarial parasite – Permanent slides
15. Cultivation and assay of viruses using embryonated eggs and Tissue culture Technique (Field visit).

IMMUNOLOGY

1. Blood smear identification of leucocytes by Giemsa stain.
2. Blood grouping.
3. Haemagglutination assay.
4. Preparation of serum from whole blood and isolation of immunoglobulins from serum.
5. Quantitative precipitin assay.
6. Determination of antigen concentration by rocket immunoelectrophoresis.
7. ELISPOT assay to detect cytokine secreting cells.
8. Determination of antigen concentration by competitive ELISA.
9. Double diffusion and Radial Immuno diffusion.
10. Complement fixation test.
11. Dot blot assays.
12. Separation of leucocytes by Ficoll method.
13. Immunodiagnostics using commercial kits – Widal [slide and tube] tests, HBsantigen.

16PBT2MC01 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

SEMESTER II **CREDITS 5**
CATEGORY MC(T) **NO.OF HOURS/ WEEK 5**

Objectives

1. To provide a basic understanding of the structure and function of DNA and RNA and the cellular processes of DNA replication, DNA repair, gene regulation, transcription and translation
2. Exposure to techniques used in contemporary molecular biology

Unit 1: Basic Genetics (1+12+2)

1. DNA- The genetic material –Transformation experiment, Hershey & Chase experiment. Semiconservative modes of replication - Replication initiation, elongation and termination in prokaryotes and eukaryotes - Replication of single stranded circular DNA.
2. Recombination in bacteria-Transformation, transduction and conjugation in bacteria.
3. Mendelian genetics, Linkage and crossing over, Chromosome mapping, Epigenetics - Introduction and applications.

Unit 2: DNA Structure, Repair & Recombination (1+12+2)

1. Organization of bacterial genome & eukaryotic genome.
2. Structure of DNA - A- DNA, B- DNA, Z- DNA and triplex DNA - DNA reassociation kinetics (Cot curve analysis).
3. DNA repair - Photo reactivation - Base excision, nucleotide Excision, Mismatch excision repair, recombination repair, SOS repair,
4. Recombination - Homologous and non-homologous, Site specific- FLP/ FRT and Cre/ Lox recombination.

Unit 3: Transcription & Translation (1+12+2)

1. Prokaryotic Transcription - Transcription unit - Promoters- Constitutive and Inducible – Operators - Regulatory elements – Initiation - Elongation ,Termination - Rho - dependent and independent - Anti-termination - Operon concept- lac, trp, ara, his,and gal operons.
2. Eukaryotic transcription and regulation - RNA polymerase structure and types - Eukaryotic promoters and enhancers - General Transcription factors - TATA binding proteins (TBP) and TBP associated factors (TAF) - Activators and repressors.
3. Post Transcriptional Modifications - Processing of hnRNA, tRNA, Rrna - 5'-Cap formation - 3'-end processing and polyadenylation - Splicing - RNA editing; nuclear export of mRNA.
4. Translation and Post translational modifications of proteins.

Unit 4: Molecular Cloning (1+12+2)

- DNA modifying enzymes - Restriction enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase

1. Cloning Vectors- Plasmids, Bacteriophages, M13 vectors, PUC19 and Bluescript vectors cosmids - artificial chromosome vectors (YACs& BACs).
2. Expression vectors - Expression cloning with pMal, GST.
3. Cloning Methodologies - Principles - Conventional and PCR based cloning. Methods of DNA transfer into cells, Construction of libraries - Hybridization techniques - Northern, Southern and Colony hybridization

Unit 5: PCR& Sequencing methods (1+12+2)

1. Principle & Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products.

2. Sequencing methods- Dideoxy method of sequencing, Automated DNA sequencing; Next generation sequencing technologies.

Books for Study :

1. Primrose, S.B., Twyman R.M., 2001. Principles of Gene Manipulation. 6th Edition, John Wiley& Sons.
2. Garderner, Simmons & Snustad, 2006, Principles of Genetics, 8th edition, Wileys.
3. Freifelder, D., 1990. Microbial Genetics, Narosa publishing house, New Delhi.
4. Lewin. B. 2008. Genes IX. Jones and Bartlett publishers.
5. Freifelder. D 2007. Molecular Biology, 2nd Edition, Narosa Publishing House.

Books for Reference :

1. Hartl DL and Jones EW., 2000. Genetics – Analysis of Genes and Genomes, 5th Edition, Jonesd and Barlett Publishers.
2. Tamarin RH., 1999. Principles of Genetics,6th Edition,WCB McGraw-Hill
3. Glick BR and Pasternak J., 1998. Biotechnology – Principles and Applications of Recombinant DNA. ASM Press, Washington, D.C.
4. Brown. T. A., 2001. Gene cloning and DNA Analysis, 4th edition – An introduction. Blackwell Science.

Websites

1. www.journals.elsevier.com/journal-of-molecular-biology/
2. http://dwb4.unl.edu/Chem/CHEM869N/CHEM869NLinks/www.dur.ac.uk/~dbl0www/Staff/Croy/cDNAfigs.htm
3. http://www.ibguides.com/biology/notes/genetic-engineering-and-biotechnology

16PBT2MC02 FERMENTATION TECHNOLOGY

SEMESTER II CREDITS 4

CATEGORY MC(T) NO.OF HOURS/ WEEK 5

Objectives

1. To provide the basics of bioreactor engineering.
2. To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

Unit 1: Concepts of fermentation processes (1+08+2)

1. Isolation, screening, strain improvement and maintenance of industrially important microbes.
2. Media formulation and sterilization for Industrial Fermentation.
3. Development of inoculum for industrial fermentations.

Unit 2: Bioreactors (1+10+2)

1. Basic design and components of a fermentor.
2. Types of Bioreactors – Stirred tank, Air lift, packed bed, fluidized bed, Photobioreactor, Membrane bioreactor, Immobilised cell bioreactors.
3. Types of fermentation – Solid state, Submerged -Batch, fed batch and continuous cultures.
4. Sterilization of fermentor.

Unit 3: Upstream and Downstream processing (1+14+2)

1. Upstream processing Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.
2. Recovery and purification – Removal of microbial cells and solid matter, Foam separation, Precipitation, filtration, centrifugation, sedimentation, flocculation; Cell disruption- physical methods and chemical methods; Liquid-liquid extraction.

3. Purification by chromatographic techniques; Reverse osmosis and ultra-filtration; Drying; Crystallization; Storage and packaging.
4. Treatment of effluent and its disposal.

Unit 4: Microbial Products – I (1+14+2)

1. Production of primary Metabolites – Amino acids production – L – Glutamic acid, L- Lysine, L – Threonine, L – Isoleucine.
2. Production of Antibiotics – Penicillin, Streptomycin.
3. Production process for Vitamins – Vitamin B12, Riboflavin, Vitamin C.
4. Production Process for Organic acids – Acetic acid, Citric acid, Lactic acid, Pyruvic acid.
5. Production of Ethanol.

Unit 5: Microbial Products-II (1+14+2)

- Production, recovery and scaling up of enzymes and their role in food and other industries – Amylase, Lipase, Cellulase, Protease.
- Immobilization of enzymes and their industrial applications.
- Biomass production – Azotobacter, B. thuringenesis, Rhizobium.

Books for Study:

1. El-Mansi E.M.T, C. F. A. Bryce, Arnold L. Demain, A.R. Allman, 2011. Fermentation Microbiology, Biotechnology, 3rdedition,CRC Press
2. Peppler H.J., D Perlma, 2014. Microbial Technology: Fermentation Technology , Acedemic press
3. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall, 2013. Principles of Fermentation Technology, 2nd Edition, Pergamon press, Oxford,
4. WimSoetaert, Erick J. Vandamme, 2010. Industrial biotechnology, Wiley- VCH

Books for Reference:

1. Rastogi, S.C. 2007. Biotechnology – Principles and Applications. Narosa Publishing House.
2. Crueger.F. and Anneliese Crueger, 2000. Biotechnology: Industrial Microbiology. Panima Publications.
3. Dubey.R.C. 2002. A Textbook of Biotechnology. S. Chand & Company Ltd., New Delhi.
4. Lilia Alberghina, 2000. Protein Engineering in Industrial Biotechnology, Harwood Academic Publishers.

Websites

1. www.edx.org/course/industrial-biotechnology-delftx-ib01x
2. http://web.mit.edu/professional/short-programs/courses/fermentation_technology.html

16PBT2MC03 ENVIRONMENTAL BIOTECHNOLOGY

SEMESTER II CREDITS 4

CATEGORY MC(T) NO.OF HOURS/ WEEK 5

Objectives

1. To study about the ecosystem, bioremediation and metal mining.
2. To ensures better understanding of environmental crisis and its remediation.

Unit 1: Basic Ecological Concepts and Principles of our Environment (1+12+2)

1. The Environment- Physical environment; biotic environment; biotic and abiotic interactions. Habitat and niche - Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
2. Community ecology- Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

3. Population ecology- Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations
4. Conservation biology - Principles of conservation, major approaches In situ and Ex situ conservation. Biodiversity-status, monitoring and documentation; National biodiversity act, Influence of anthropogenic activity on biodiversity.

Unit 2: Pollution and Environmental regulations. (1+12+2)

1. Classification and nature of Environmental Pollutants; Major sources; Impacts of Environmental Pollution at local regional and global level.
2. Case studies on pollution- Delhi Air pollution, Ganges river case study, Chernobyl nuclear power plant accident, Delhi Noise pollution, and Kerala Endosulfan tragedy.
3. Environmental protection act 1986, Prevention, Control and abatement of Environmental pollution. Powers and Functions of central pollution control boards.
4. Environmental Monitoring- Concept of Remote sensing & Geographical Information System (GIS).

Unit 3: Waste water management (1+12+2)

1. Sewage and waste water treatments systems: Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments.
2. Effluent treatment- sugar industries, starch industries, textile industries, dairy industries, breweries, distilleries, petroleum industry, tannery, paper and pulp industries.

Unit 4: Solid waste management1 (1+12+2)

1. Basic aspects of solid waste management- current practice of solid waste management in India- waste disposal by sanitary landfilling.

2. Aerobic treatment of solid wastes- Composting and vermiculture.
3. Anaerobic treatment –Biogas production.
4. Treatment of hazardous waste, biomedical waste.

Unit 5: Biotechnological applications in environment

(1+12+2)

1. Bioremediation of petroleum hydrocarbons.
2. Biodegradation of Xenobiotics - types and fate of pesticides, reasons for persistence, microbial adaptation of pesticides and biodegradation of pesticides.
3. Microbes in heavy metal remediation - need for metal bioremediation, metal availability, metal microbe interaction, bioremediation techniques, microbes for metal remediation, mechanisms of microbial metal tolerance (active and passive) and genetics aspects of heavy metal resistance.
4. Microbes in bioleaching process- Metal recovery by leaching process, Recovery of petroleum, production of fuels.
5. Phytoremediation - Rhizofiltration, phytoextraction, phytostimulation, phytostabilization, and phytotransformation

Books for Study:

1. Madhab Chandra Dash and Satya Prakash Dash, 2009; Fundamentals of Ecology, 3rd edition; Tata Mc Graw Hill, New Delhi.
2. Mohapatra.P.K. 2006. Textbook of Environmental Biotechnology, 1st edition, I.K. International Publishing House Pvt. Ltd.
3. Michael C.Newman, 2015. Fundamentals of Ecotoxicology: the science of pollution 4th edition, CRC press.
4. Odum E.P., 2005. Fundamentals of Ecology, Thomas brooks and Cole.

5. Sharma BK, 2007. Environmental Chemistry, 2007, 11th Edition, Goel Publishing House, Meerut.

Books for Reference:

1. Bhatia.S.C. 2008. Handbook of Environmental Microbiology (1, 2 and 3). Atlantic Publishers and Distributors (P) Ltd.
2. Thakur, I.S. 2006. Industrial Biotechnology – Problems and Remedies. I.K.InternationalPvt.Ltd.
3. Sharma, P.D. 2006. Environmental Microbiology. Narosa Publishing House
4. Murugesan.A.G. and Rajakumari.C. 2005. Environmental Science and Biotechnology – Theory and Techniques. MJP Publishers, Chennai.
5. Asthana.D.K. and Asthana, M. 2006. A Textbook of Environmental Studies. S.Chand& Company Ltd., New Delhi.
6. Scragg, A 2007. Environmental Biotechnology,2nd Edition, Oxford University Press.
7. Mohapatra, P.K. 2007. Textbook of Environmental Biotechnology. I.K.International Publishing House Pvt.Ltd.

Websites

1. www.omicsonline.org/jpebhome.php2.
2. www.nature.com/subjects/environental-biotechnology.

16PBT2MC04 LAB - III

(Mol.Bio & Gen. Eng. / Fer. Tech/ Envir. Biotech)

SEMESTER II	**CREDITS 7**
CATEGORY MC(L)	**NO.OF HOURS/ WEEK 9**

Objectives

1. To enable the students to get a hands-on experience in handling the nucleic acid samples and their products.
2. To enable the learners to develop skills in industrial applications of microorganisms, experimenting with enzymes and exploring the practical uses of enzymes.

3. To provide good exposure in handling and studying environmental samples so that the learner is well equipped to handle current environmental issues.

MOLECULAR BIOLOGY& GENETIC ENGINEERING

1. Isolation of Genomic DNA.
2. Isolation of plasmid DNA.
3. Isolation of RNA.
4. Bacterial Cloning
5. Preparation Of Vector DNA (Digestion and purification)
6. Elution
7. Ligation
8. Amplification
9. Transformation, Calculation of transformation efficiency.
10. 16s rRNA PCR
11. RAPD based differences in two different species of maize.
12. Southern blot.
13. Sequencing (DEMO)

FERMENTATION TECHNOLOGY

1. Components of fermenter.
2. Yeast – Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient.
3. Effect of sugars (fructose, sucrose and fructose) on the growth kinetics of yeast.
4. Amylase immobilization by alginate gel method
5. Hydrolysis of starch by immobilization method
6. Shake flask culture of *A. niger* and detection of citric acid by acetic anhydride and pyridine methods.
7. Standard curve of reducing sugar by DNSA method.
8. Liquid -liquid extraction of fermented broth.
9. Production of wine.

ENVIRONMENTAL BIOTECHNOLOGY

1. Estimation of chlorides, organic carbon in soil.

2. Determination of hardness, acidity and alkalinity of water sample.
3. Estimation of nitrate in drinking water.
4. Determination of dissolved oxygen concentration of water sample.
5. Determination of biological oxygen demand of sewage sample.
6. Detection of coliforms for determination of the purity of potable water.
7. Oil degradation by Pseudomonas.
8. Production of microbial fertilizers (Rhizobium, Azotobacter and AMF).
9. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry (Field visit).

16PBT2ES01 HUMAN GENETICS

SEMESTER II **CREDITS 3**
CATEGORY ES(T) **NO.OF HOURS/ WEEK 4**

Objectives:

This course has been developed to introduce students to human genetics and the background of genetic diseases.

Unit-1: Molecular basis of human genetics (1+10+1)

1. Genes, Repetitive sequences, Single nucleotide polymorphisms
2. Mutations – Numerical mutations (Aneuploidy)
3. Structural Mutations - Triploidy, tetraploidy, isochromosomes, Ring chromosome, Marker chromosome, Translocations- Reciprocal & Robertsonian translocation
4. Gene Mutations -constitutional and somatic –point mutations, nonsense, missense, Splice site mutations, Frame shift mutations, Gain of function and loss of function mutation, CpG mutations, Large genomic rearrangements.

Unit 2: Genetic diseases (1+10+1)

1. Genetics in Medical Practice - Genetic Principles and their application in medical practice.
2. Pattern of inheritance of genetic disorders - Sex linked diseases and autosomal linked diseases.
3. Genetics of Neurogenetic disorders - Charcot-Marie tooth syndrome, Spinomus cularatrophy, Alzheimer's disease & Syndromes.
4. Genetic basis of muscle disorders - Duchenne Muscular dystrophy and Becker Muscular Dystrophy.
5. Single gene disorders - Detection – Positional cloning, Candidate gene approach
6. Multifactorial inheritance and twin studies - Detection – Model free linkage analysis, Linkage disequilibirium analysis.

Unit 3: Gene therapies and cell therapies (1+10+1)

1. Pharmacogenetics and pharmacogenomics; Genetic variation for drug response
2. Gene therapy- gene delivery strategies and mechanisms. Gene augmentation therapy for recessive diseases involves transferring a functional copy of the gene into the genome,
3. Gene medicine-Nucleic acids as drugs, antisense drugs, ribozyme drugs, aptamer drugs, role of siRNA in combating diseases
4. DNA vaccines, Stem cell therapy and organ transplants

Unit 4: Genetic Evaluation (1+10+1)

1. Genetic counseling- Models of genetic counseling, Historical overview (philosophy & ethos) and components of genetic counseling.
2. Genetic testing: biochemical & molecular tests - Prenatal and Preimplantation screening and diagnosis, Noninvasive methods-Ultrasound, Embryoscopy, MRI, Invasive methods- Prenatal screening for Down's syndrome (maternal serum) & Neural tube defects.

Presymptomatic testing for late onset diseases (predictive medicine).

3. Ethical issues in prenatal screening and diagnosis.

Unit 5: Human genetics in paternity issues & crime scene

(1+10+1)

1. Chromosome X short tandem repeats, Power of chromosome X markers in trace analysis and kinship testing
2. Chromosome X marker mapping and haplotype distribution in different populations.
3. Ethical considerations in chromosome X marker testing.
4. Mitochondrial DNA biology – polymorphic regions, screen assay & sequencing
5. Y chromosome markers in forensic genetics
6. Identification of male sex, male lineage
7. Identification of male paternity, males geographical origin,
8. The future of y-chromosomal markers in forensics.

Books for Study

1. Schaaf.C.P., Zschocke, JPotocki,L., 2011. Human Genetics: From Molecules to Medicine, Lippincott, Williams & Wilkins.
2. Sandy B. Primrose, Richard Twyman, 2003. Genomics - Applications in Human Biology, Wiley Black well.
3. Jogdand, S. N. 2000. Medical Biotechnology, Himalaya Publishing house, Mumbai.
4. Glick, B. R. and Pasternak. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA. ASM Press.

Books for Reference

1. Wendy R. Uhlmann, Jane L. Schuette, Beverly Yashar, 2011.A Guide to Genetic Counseling, 2nd edition, Wiley – Blackwell., 2003.
2. Peter S. Harper, Practical Genetic Counselling, 7th Edition, Taylor & Francis group.

3. Angus Clarke, 1994. Genetic Counselling: Practice and Principles, Routledge publishers.
4. Ralph Rapley& David Whitehouse, 2007. Molecular Forensics, John Wiley & Sons.
5. Richard Li, 2011.Forensic Biology: Identification and DNA Analysis of Biological Evidence, CRC Press.

Websites

1. https://biology.mit.edu/research/human_genetics
2. http://highered.mheducation.com/sites/007246268x/student_view0/index.html

16PBT2ES02 BIOANALYTICAL TECHNIQUES

SEMESTER II CREDITS 3
CATEGORY ES(T) NO.OF HOURS/ WEEK 4

Objectives

1. To provide an understanding of the equipment's and it applications used in Bio-technology.

Unit 1: Centrifugation (1+10+1)

1. Principles of Sedimentation, Types of Centrifuges [differential, rate-zonal and density gradient centrifugation (CsCl, sucrose)]. Preparative and analytical centrifugation.
2. Applications – Methods of cell disintegration, sub-cellular organelles, viruses and macromolecules.

Unit 2: Separation techniques (1+10+1)

1. TLC and Paper chromatography, Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Affinity chromatography; HPLC
2. Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit 3: Spectroscopy (1+10+1)

1. Electromagnetic radiation – wave properties, particle properties, electromagnetic spectrum.
2. Theory and application of IR,UV, Visible Spectroscopy, Circular Dichroism and Luminometry, fluorescence spectroscopy, Atomic Absorption

Unit 4: Elementary crystallography (1+10+1)

1. Protein crystallization, solving the structure of crystal-applications of X ray crystallography.
2. Molecular modeling.
3. Protein identification -Mass spectrometry-ESI, MALDI-TOF.
4. Radiation biophysics: detection of radiation by ionization chamber, G.M counter, Liquid scintillation counter.

Unit 5: Bioanalytical techniques in Medicine (1+10+1)

1. Electrophysiology and bio-potentials, Polarisation and depolarisation of the cell Measurement of bio potential.
2. Principles of electro-encephalogram, electro-cardiogram and electro-retionogram
3. Imaging techniques- Computed tomography, Positron Emission Tomography, Magnetic resonance imaging.
4. In vivo imaging and functional studies of brain, thyroid, heart, biliary tract, liver, kidney, spleen, tumors, bones and abscesses, use of imaging devices and external detectors for organ

Books for Study:

1. Ian Campbell.D., 2012. Biophysical techniques, 1st edition. Oxford University Press. Wilson. K and Walker.J, 2010. Principles and techniques of Practical Biochemistry, Cambridge University Press.

Books for Reference:

1. Cotterill. R, 2003.Biophysics: An Introduction. John Wiley & Sons.

2. Igor N. Serdyuk, Nathan R. Zaccai, Giuseppe Zaccai. 2007. Methods in Molecular Biophysics: Structure, Dynamics, Function. Cambridge University Press.
3. Thomas D. Gelernter, Francis S. Collins and David Ginsburg, 1998. Principles of Medical Genetics, 2nd Edition, Williams and Wilkins.
4. Trent, R.J., 1997. Molecular Medicine, 2nd edition. Churchill Livingstone
5. Dorian J. Pritchard and Bruce R. Korf, 2004. Medical Genetics at a glance. Blackwell Science

16PHE2FC01 LIFE SKILLS TRAINING

SEMESTER II CREDITS 2
CATEGORY FC(T) NO.OF HOURS/ WEEK 2+2

OBJECTIVES OF PG SYLLUBUS

1. To improve and sustain the primal level of competence and performance of PG students through an advanced training of holistic development of oneself.
2. To empower through various skills and strengthen them to face the future life issues and challenges.
3. To equip them with practical and value based learning of soft skills for a better life in future.

INSIDE CLASS HOURS (2 hrs)

Unit – I: Constructing Identity

Self Image – Understanding self image – shadows down the lane – self acceptance - Self Knowledge – Knowing oneself - Self confidence – Guilt and grudges - Power of belief – positive thinking– optimizing confidence - Self development – perception, attitude and Behavioural change, developing a healthy and balance personality - Self esteem – signs - indicators

Unit – II: Capacity Building

Motivation – Definition, types (Intrinsic and Extrinsic), Theories (Maslow's hierarchical needs, etc), Factors that affect

motivation, Challenges to motivation, Strategies to keep motivated, motivational plan. Time Management Skills– steps to improve time management, overcoming procrastination, assessing and planning weekly schedule, challenges, goal settings, components of goal settings, consequences of poor time management, control of interruption and distractions.

Communication, public speaking, talents, creativity, learning,

Unit – III: Professional Skills

-Leadership development skills – difference between leader and manager, different styles and their utilities, functions of leadership, application of knowledge, overcoming from obstacles, influential skills and Leadership qualities. Application skills – Managing Career and self-direction, Visionary thinking, formulating strategies, shaping strategies, building organizations relationships, change management. Project Management Skills, Independent working skills, Writing skills, Public Speaking, analytical Skills, Neo Research and Development. Problem solving skills – Process, approaches and its components, creative problem solving, Tools and techniques, application of SMART analysis and barriers to problem solving.

Unit – IV: Life Coping Skills

Life skills – Personal and reproductive Health, love, sex, marriage and family – family life education – Gender Equity - child bearing and Childrearing practices, Geriatric Care - adjustability Human Relationship – formal and informal - peer group – friends – same and other gender - family – Colleagues – community – emotional intelligence - Stress Coping skills – Definition of stress, strategies to alleviate stress, problem and emotion focused coping, techniques to reduce stress, stress reaction phases, crisis intervention steps, creating positive affirmations, Signs, Symptoms and Reactions of Stress.

Unit – V: Social Skills

Human Rights Education, Understanding Human Rights, International and national mechanisms, protection and

preservation of HRs, Human Rights in the context of new, technological and electronic society, Peace Education, Social Harmony in the context of religious fundamentalism and fanaticism, Understanding Peace and Justice, Conflict Resolution Strategies

Reference books

1. Healing Your Emotional Self: A Powerful Program to Help You Raise Your Self-Esteem, Quiet Your Inner Critic, and Overcome Your Shame by Beverly Engel
2. Self-knowledge and self-discipline by B. W. Maturin
3. Motivation: Biological, Psychological, and Environmental (3rd Edition) by Lambert Deckers
4. Getting Things Done: The Art of Stress-Free Productivity by David Allen
5. Managerial Skills in Organizations by Chad T. Lewis
6. Social Intelligence: The New Science of Human Relationships by Daniel Goleman

Competence building	Career Preparatory Training
Power talk	Interview Guidance
Emotional Intelligence	Group Dynamics
Stress management	Leadership skills
Decision Making	Negotiation Skills
Positive image building	Creative writing

OUTSIDE THE CLASS HOURS (2 hrs)

1. Each student will choose either of the above-mentioned modules and is expected to undergo a training/workshop in that module.
2. She/he will have to accomplish ten hrs outside the class hours to fulfill the 2 credits.

Methodology

Inputs, ABL model, Documentaries, group activities and Interaction, Special workshop by professionals.

Evaluation

There will be end test and a Project for 'inside the class hours'. Viva Voce will be conducted for the 'Outside the class hours'.

16PBT3MC01 ANIMAL BIOTECHNOLOGY

SEMESTER III	**CREDITS 4**
CATEGORY MC(T)	**NO.OF HOURS/ WEEK 5**

Objectives:

1. To enable the students to know the basics of animal cell culture, and their various applications in the field of biotechnology.
2. To provide the basic understanding on the regenerative medicine, and different ways in which molecular techniques could be applied for the improvement of animals.

UNIT 1: Animal cell culture (1+12+2)

1. Structure of animal cell, History of animal cell culture, culture of mammalian cells, tissues and organs, Culturing Gametes - embryo culture.
2. Cell lines - definition, types (finite, continuous/established, transformed), culture types- primary culture, secondary culture, cell lines
3. Commercial scale production of animal cells ; Scale-up in suspension- Rotating chambers, Perfused suspension cultures, Fluidized bed reactors for suspension culture, Scale-up in monolayers - Multisurface propagators, Roller culture
4. Microcarriers - Perfused monolayer cultures, Microencapsulation, Characteristics of finite, continuous and transformed cells.

Unit 2: Maintenance of cell cultures and applications of cell lines (1+12+2)

1. Phases of cell growth, Subculture of cells, Characterization of cell lines
2. Microbial contamination of cell culture - Cell viability tests for cells in culture
3. Tumorigenesis assays – histological examination, transplantation, CAM assay, organoid confrontation, filter well invasion
4. Cryopreservation principle, cryoprotectants, Cryopreservation of cell lines, sperm and embryos
5. Application of animal cell culture for in vitro testing of drugs, toxicity testing, production of human and animal viral vaccines and pharmaceutical proteins.

Unit 3: Stem cells and Tissue Engineering (1+12+2)

1. Stem cell types based on potency, Embryonic stem cells, Adult stem cells, culturing stem cells at various stages
2. Induction of stem cell differentiation - Induced pluripotency of adult stem cells and its applications – histotypic and organ culture.
3. Tissue engineering – types of Scaffolds /support materials; Scaffold fabrication methods, tissue-engineered skin, genetically engineered tissues - peripheral nerve implant, cartilage, uterus, trachea, urinary bladder.

Unit 4: Genetic manipulation of animal cells (1+12+2)

1. Genetic engineering of animal cells, Animal Virus derived vectors-SV-40; vaccinia/ retroviral vectors , baculovirus vectors based transfection for production of recombinant proteins
2. Animal cloning-somatic cell cloning and hybridization, transgenic animals- Production of transgenic cattle, sheep, birds, ornamental fish.

3. Pharming and applications, application of cell culture technology in production of human and pharmaceutical proteins
4. Gene Knock out studies-Animals as disease models-Diabetes, Cancer, Neurodegenrative disorders.
5. Ethics and legal issues in Genetic Engineering - John Moore case study, Stem Cell Research, Concerns of Genetically Modified Organisms, Altering human genome - Gene therapy.

Unit 5: Tools for assisted reproduction and genetic improvement (1+12+2)

1. Artificial insemination and Crossbreeding, Progeny Testing, Embryo transfer technology, Oestrus synchronization, Super ovulation
2. Transgenic manipulation of animal embryos, In vitro fertilization, In vitro maturation, embryo-splitting, embryo sexing.
3. DNA based markers- SNP, STR, RFLP, and RAPD for Livestock improvement.
4. DNA Barcoding of animal species, Application of RNA interference technology in animal farming.

Books for Study

1. Hafez. B, E.S.E Hafez, 2000. Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell.
2. Glyn N Stacey, John Davis, 2007. Medicines from animal cell culture, John Wiley and Sons, USA.
3. Ian Freshney R., 2010. Culture of animal cells; A manual of basic technique and specialized applications, John Wiley and Sons, USA.
4. Robert Lanza, 2013. Essentials of stem cell biology, 3rd edition, Acadaemic press.
5. Scott F Gilbert, 2014. Developmental Biology, 10thEdition, Sinaeur Associates.
6. Twyman R.M., 2009. Advanced Molecular Biology, Bioscientific, Oxford, UK.

Books for Reference

1. Decker J & Reischl. U, 2004. Molecular Diagnosis of infectious diseases, 2nd Edition, Humana Press.
2. Geordge E. Seidel, Jr. and Sarah Moore Seidel, 1991. Training Manual for Embryo Transfer in Cattle.
3. Gordon I, 2004. Reproductive techniques in farm animals, CABI
4. John R.W. Masters, 2000. Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press,

Websites

1. www.animalscience.ucdavis.edu
2. www.gslc.genetics.utah.edu
3. www.biotechnology.gov.au
4. www.scientificamerican.com

16PBT3MC02 PLANT BIOTECHNOLOGY

SEMESTER III **CREDITS 4**
CATEGORY MC(T) **NO.OF HOURS/ WEEK 5**

Objectives:

1. To provide detailed information about the tissue culture practices for micro-propagation and other applied aspects.
2. To apply in formation about the biotechnology in agriculture.

Unit 1: Basics of Plant Tissue Culture (1+12+2)

1. History of Tissue Culture technique, Totipotency. Requirements for a Cell Tissue Culture lab.
2. Nutrient media: Composition of commonly used nutrient culture media with respect to their contents like inorganic chemicals, organic constituents, vitamins, amino acids etc.
3. Sterilization of the media.

4. Plant tissue culture – Totipotency – Plant cell culture media - Callus and suspension cultures – Somaclonal Variations - Organogenesis and Somatic embryogenesis and hardening of plants - anther, embryo and ovule culture
5. Protoplast isolation, culture and regeneration of plants.
6. Somaclonal variations, isolation of somaclonal variants. Molecular basis of somaclonal variation.
7. Production of virus free plants- shoots meristem culture. Thermotherapy, cryotherapy and chemotherapy. Virus indexing. Maintenance of virus free stocks.
8. Cryopreservation

Unit 2: Plant transformation techniques: (1+12+2)

1. Plant biotechnology tools for crop improvement
2. Molecular markers - Restriction based
3. PCR based markers – RFLP, RAPD, AFLP, ISSR, SNP
4. Development of SCAR and SSR markers
5. Marker assisted selection and breeding – Selectable markers, reporter genes and promoters used in plant vectors
6. Gene transfer methods-Agrobacterium mediated-gene transfer, Gene gun method, Microinjection technique and Electroporation
7. SAAT and floral dip transformation technique in Arabidopsis
8. Antisense technology and RNAi applications in plant biotechnology.

Unit 3: Recombinant products (1+12+2)

1. Crop improvement by induced in vitro mutations. Production of variants by physical or chemical mutagens.
2. Genetic engineering for biotic stress (insects, fungi, bacteria, viruses)
3. Genetic engineering for abiotic stress tolerance (drought tolerant, salt tolerant) and herbicide resistance

4. Novel genes used in plant genetic engineering - Gene pyramiding
5. Genetic engineering for enhanced nutritional value of food– Golden rice
6. Engineered Therapeutic protein production in plants; edible vaccines; chloroplast genetic engineering - Plantibodies

Unit 4: Pathogenesis related Proteins and Bioactive compounds (1+12+2)

1. PR proteins- Bacterial resistant genes and fungal resistant genes
2. Defense mechanism: Biology of plant-pathogen interaction. Phytoalexins
3. - Phytochemical compounds produced in plants: Nitrogen containing compounds, Alkaloids, Phenolics (Anthocyanins, Benzofurans, Coumarins, Flavones and Tannins), Plant pigments and terpenoids (Monoterpenoids, Diterpenoids,Triterpenoids, Phytosterols, Carotenoids)
4. Quantitative and qualitative estimation of phytochemicals, Methods for separation of phytochemicals- HPLC.
5. Plant cell culture based bioreactor production of plant secondary metabolites.

Unit 5: IPR & Patenting (1+12+2)

1. Intellectual Property Right (IPR) and Protection (IPP), IPR and Plant Genetic Resources (PGR). National and international regulation: National Biodiversity Act, Protection of Plant varieties and Farmer's Right Act and Nagoya Protocol on Access of Bioresouces and Benefit sharing.
2. Patenting of biological material: International conventions, international corporations, patent applications, implication of patenting of higher plants, patenting transgenic organisms and isolated genes, patenting of genes and DNA sequences.

3. Biosafety – Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture - Cartegena Protocol and food safety– Ethical issues and Resilience of GM crops.

Books for Study:

1. Adrian Slater, Nigel W. Scott and Mark Fowler R, 2008. Plant biotechnology - the genetic manipulation of plants,2nd edition
2. Chawla HS, 2010. Introduction to Plant Biotechnology (3rd edition) CRC Press
3. Nigel Halford, 2014. Plant Biotechnology – Current and Future Applications of Genetically Modified Crops. Wiley Publishers.
4. Zingare AK, 2013. Biotechnology in Plant Improvement. Satyam Publishers
5. RaoGP, Yipeng Zhao, Radchuk VV and Bhatnagar SK, 2008. Advances in Plant Biotechnology.Studium Press LLC
6. Raaman N 2006. Phytochemical techniques. New India Publishers.
7. Ignacimuthu S. 1998 Plant Biotechnology. Oxford and IBH

Books for Reference:

1. Arie Altman and Paul Michael Hasegawa, 2011. Plant Biotechnology and Agriculture: Prospects for the 21st Century, 1st edition, Academic Press.
2. Christou P, 2010. Handbook of Plant Biotechnology, Vol 2. Wiley Publishers.
3. Mishra RC. 2010. Plant Biotechnology. ABD Publishers.
4. Bhatia, Sharma, Dahiya, Bera, 2015. Modern Applications of Plant Biotechnology in Pharmaceutical Sciences, 1st edition, Academic Press.
5. Bahadur B, VenkatRajam, Sahijram L and Krishnamurthy KV, 2015. Plant Biology and Biotechnology Vol II Plant Genomics and Biotechnology. Springer Publishers.

16PBT3MC03 RESEARCH METHODOLOGY AND BIOINFORMATICS

SEMESTER III **CREDITS 4**

CATEGORY MC(L) **NO.OF HOURS/ WEEK 5**

Objectives:

1. To understand the overall process of designing a research study from its inception to its report.
2. To introduce the various biological database, servers & tool in bio fermatas.

Unit 1 Data analysis & Presentation (1+12+2)

1. Objectives of Research - Formulation of Research problem - Hypothesis development and Testing - Writing a Research Proposal.
2. Collection of review of scientific literature, on-line and off-line sources - Design of experiments – principle, procedure in effective design.
3. Experimental Design and methods – control, natural, observational, field experiments
4. Data – types, collection and classification - Sampling – types, methods, sample size.

Unit 2 Biostatistics (1+12+2)

1. Biostatistical methods of analysis- Descriptive statistics- Measures of Central tendency –Measures of dispersion.
2. Inferential Statistics – ANOVA, Regression and Correlation analysis, Multivariate analysis, Spatial Statistics.
3. SPSS Package and MS Excel- Data representation (tabulation, diagrammatic, graphical – Venn diagram, Pie chart, graphs , Bar- chart, Histogram)

Unit 3 Bioinformatics: An introduction (1+12+2)

1. Internet Basics-world wide web-Internet resources for research - Emergence of bioinformatics -Historical overview.
2. Bioinformatics Resources: Nucleic acid sequence databases - GenBank, EMBL, and DDBJ.
3. Protein databases - SWISS-PROT, TrEMBL, PIR, PDB.

4. Genome Databases at NCBI, EBI, TIGR, SANGER, other Databases for Patterns/Motifs/System Biology (Gene and protein network database and resources)
5. Sequence data formats - Primary databases- Flat file formats, secondary databases, Data retrieval systems.

Unit 4 Sequence Analysis (1+12+2)

1. Introduction to Sequence similarity, identity and homology
2. Alignment Algorithms - Gaps, Gap penalties, Scoring matrices, Alignment score
3. Local alignment and Global alignment, Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).
4. Basic concepts and applications, whole genome alignments Artemis, BLAST2, MegaBlast algorithms, PipMaker, AVID, Vista, MUMmer,
5. Gene predictions – Abintio & comparative gene predictions. Prediction of Cis acting elements.

Unit 5 Molecular Phylogenetics (1+12+2)

1. Biological evolution and principles of Darwinism, Molecular basis of evolution, Factors affecting gene frequency in population, Neutral theory of evolution, Molecular clock hypothesis
2. Molecular basis of Phylogenetic analysis:-Evolution, elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life,
3. Clasdistics – basic concepts. Principles of phylogenetic tree construction, tools for phylogenetic analysis - Phylip, ClustalW. Species trees and gene trees

Books for Study:

1. Baxevanis A. D., Ouellette B. F. F., 2005. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins, 3rd edition, Wiley's Publications.
2. Choudhuri.S, 2014. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools.

3. Kothari, C.R., 2008. Research Methodology: Methods and Techniques, 2nd revised edition, New Age International.

Books for Reference:

1. Venkatarajan S. M., Pandjassarame K. 2009. Bioinformatics: A Concept-Based Introduction, Springer publications.
2. Mount, D. W. 2004. Bioinformatics: sequence and genome analysis. Cold Spring Harbour Laboratory Press.
3. Ramsden, J. 2009. Bioinformatics: An introduction. Kluwer Academic Publishers
4. Pathak R.P., 2008. Methodology of Educational Research. Atlantic Publishers & Dist

16PBT3MC04 LAB- IV
(Animal Biotech/ Plant Biotech)

SEMESTER III **CREDITS 3**
CATEGORY MC(L) **NO.OF HOURS/ WEEK 5**

Objectives:

1. To provide the practical background and training in animal cell culture and molecular techniques related to animal biotechnology
2. To equip students with the essential skills to apply and explore theoretical concepts of animal biotechnology in the laboratory.
3. To enable the students to acquire skills in in vitro regeneration of plants and also expose them to molecular techniques using plants.

ANIMAL BIOTECHNOLOGY

1. Preparation and sterilization of reagents and media for cell culture.
2. Candling and Primary culture of chick embryo fibroblasts, Cardiomyocytes

3. Cell counting using haemocytometer.
4. Culturing of spleen cells and Viability test - Dye exclusion assay.
5. MTT Cell viability assay.
6. Myeloma cell culture, Subculture and Cryopreservation of cell lines.
7. Fusion of cells by PEG.
8. Exposure of cells to carcinogens and transformation assay (focus assay or soft agar assay).
9. Isolation of DNA from mammalian blood or spleen.
10. Comet assay for assessing genotoxicity.
11. Field visit- Assisted reproduction

PLANT BIOTECHNOLOGY

1. Preparation of Plant Tissue Culture Media
2. Callus induction
3. Micropropagation
4. Isolation of plant DNA by CTAB and agarose gel electrophoresis
5. Quantification of DNA and RNA in plant tissues by spectrophotometer method
6. Agrobacterium mediated gene transformation
7. Histochemical staining for GUS assay
8. Isolation of Rhizobium from legumes
9. Protoplast isolation
10. Screening, isolation and purification of pigments compounds from plants by column chromatography
11. Assay for bioactive compounds (alkaloids – Hager's test, carbohydrates – Molish's test, flavonoids – Alkaline reagent test, saponins – Frothing test, Phytosterols – Libermann- Burchard test) and TLC
12. Barcoding in different plant genera using ITS primers.
13. Demo: Biolistic Gun Transformation

16PBT3ES01 NANOTECHNOLOGY

SEMESTER III **CREDITS 3**
CATEGORY ES(T) **NO.OF HOURS/ WEEK 4**

Objectives:

1. To make the students familiar with the basic concepts of nanotechnology.
2. To gain fundamental understanding of nanotechnology, principles and also its implications.
3. To explain the theory, applications and scientific experimentations on nanotechnology.

UNIT 1: Basic concepts of Nanotechnology (1+10+1)

1. Definition, History of nanotechnology - Nanomaterials - Biomimetic nanomaterials - Self-assembled nanomaterials - Nanostructured metals and alloys
2. Polymers - Semiconductors (Quantum dots, Semiconducting oxides, Titanium dioxide, Zinc dioxide, Indium tin oxide, Photonic crystals)
3. Composites - Nanocoatings - Natural nanomaterials
4. Nanotechnology in consumer products - - Feynman's speech - Faraday's study on gold colloids - GMR effect - Fullerenes and carbon nanotubes
5. Raw materials of nanotechnology (nanoparticles, nanofibres, nanoplates and graphene based materials) - Properties of nanostructures (Surface properties, electrical properties, optical properties, mechanical properties and magnetic properties).

UNIT 2: Nanodevices (1+10+1)

1. Biological motors and cost of control – Biophotonic devices – DNA as construction material
2. Protein nanoparticles - Biologically inspired nanomaterials - Nanoparticle-assisted polymerase chain reaction technology – Theragnostics
3. Production of functional foods - Nanocomposites in food packaging - Toxicity and environmental risks of

Nanomaterials - Safety, ethical and economic issues in nanotechnology

UNIT 3: Characterization of Nanomaterials (1+10+1)

1. X-Ray Characterization and Diffraction (X-ray powder diffraction – single crystal diffraction techniques)
2. Determination of accurate lattice parameters - structure analysis - profile analysis - particle size analysis using Scherer formula)
3. Thermal Analysis Methods (Principle and Instrumentation of Thermogravimetry - Differential Thermal Analysis and Differential scanning calorimetry - Importance of thermal analysis for nanostructures)
4. Spectroscopic techniques (Spectroscopy and Applications - Microwave Spectroscopy - Raman Spectroscopy and CARS Applications - Electron Spin Resonance Spectroscopy - New Applications of NMR Spectroscopy - Dynamic Nuclear Magnetic Resonance; Double Resonance Technique)

UNIT 4: Nanofabrication (1+10+1)

1. Scanning Electron Microscopy - Transmission Electron Microscopy- Atomic Force Microscopy - Scanning tunneling Microscopy
2. Lithography - Patterning of thin films - Conventional lithography - Photolithography - Scanning lithography - E-beam lithography - Soft lithography
3. Nanocontact printing - Nano-imprint lithography - Nanosphere lithography - Colloidal lithography

UNIT 5: Applications of Nanotechnology (1+10+1)

1. Medicine and healthcare – Diagnosis Biosensors, Cantilever biosensor, Plasmonic biosensors, Artificial nose biosensor, Microarrays, Nanobarcodes, Lab-on-a-chip.
2. Imaging Diagnostic imaging, In situ diagnostic devices - Therapy - Drug development and targeted drug delivery, Drug design and screening, siRNA drug delivery,

Stimuli - activated drug delivery, Current and future nano - drug carriers, Externally activated therapies that use nanoparticles, Theranostics.

3. Regenerative medicine Tissue and biomaterial engineering, Nanoengineering bone regeneration, Nanoengineering neuron regeneration, Neuron tissue engineering, Neuroprosthetics, Neuronal stimulation, monitoring and pain management, Non - invasive brain - machine interfaces.
4. Environment Remediation and mitigation, Pollution prevention, Environment sensing, Food packaging and monitoring) – Energy Solar energy, Hydrogen society, Thermoelectricity, Rechargeable batteries, Energy savings.
5. Information and Communication Technologies Integrated circuits, Data storage, Photonics, Displays, Information storage devices, Wireless sensing and communication.
6. Nanotechnology in agriculture- nanoparticle based pesticides.

Books for Study

1. Alain Nouailhat, 2008. An Introduction to Nanoscience and Nanotechnology. ISTE Ltd and John Wiley & Sons, Inc.
2. Christof M. Niemeyer and Chad A. Mirkin, 2004. Nanobiotechnology: Concepts, Applications, and Perspectives, Wiley-VCH, Weinheim, Germany.
3. Jeremy Ramsden, 2009. Essentials of Nanotechnology, Jeremy Ramsden and Ventus Publishing ApS.
4. Kewal Jain K, 2008. The Handbook of Nanomedicine. Humana Press.
5. Mark Ratner A, Daniel Ratner, 2003. Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall Professional, New York.
6. Murty BS, Shankar P, Baldev Raj, Rath BB, James Murray, 2013. Textbook of Nanoscience and Nanotechnology, Springer Berlin Heidelberg.

7. Thomas D. Gelehrter, Francis S. Collins and David Ginsburg, 1998. Principles of Medical Genetics, 2nd edition, Williams and Wilkins.

Books for Reference

1. Dorian J. Pritchard and Bruce R. Korf, 2004. Medical Genetics at a glance. Blackwell Science.
2. Claudio Nicolini, 2008.Nanobiotechnology and Nanobiosciences, Pan Stanford Publishing, Singapore.
3. Patrick Boisseau, Marcel Lahmani, 2009. Nanoscience: Nanobiotechnology and Nanobiology, Springer, UK
4. Geoffry M. Cooper, 1990. Oncogenes, Jone and Barlett Publishers
5. Ramachandran A and Chandran M.R., 2006. Forensic Medicine and Technology, All India Publishers and Distributors.

Website

1. www.understandingnano.com
2. www.nanowerk.com

16PBT3ES02 CANCER BIOLOGY

SEMESTER III CREDITS 3
CATEGORY ES(T) NO.OF HOURS/ WEEK 4

Objectives:

1. To explore the cellular and molecular mechanisms underlying cancer development with the aim of understanding how changes in the normal growth and division processes lead to the formation of tumours.
2. To understand the current concepts of cancer, including cancer diagnosis, cancer treatment and prevention

UNIT 1: Fundamentals of cancer biology (1+10+1)

1. Introduction to cancer - Forms of cancer - benign, malignant - Classification of cancers – (carcinoma, sarcoma, lymphoma, myeloma, leukemia)
2. Microscopic and macroscopic features of neoplasm
3. Regulation of cell cycle

4. Mutations that cause changes in signal molecules
5. Effects on receptor, signal switches
6. Causes of cancer
7. Experimental models for the study of carcinogenesis
8. Identification and histopathology of cancers
9. Multistep tumorigenesis
10. Metastasis – Metastasis suppressor and metastasis promoter genes - Stage and grade of neoplasms
11. Apoptosis and cancer
12. Angiogenesis

UNIT 2: Epidemiology and cell biology of human cancers

(1+10+1)

1. Lung, Breast, Colorectal, liver, pancreatic, cervical, ovarian, endometrial, skin and prostate cancers, leukemia
2. Various factors in development of cancer
3. Growth factors (IGF – NGF – EGF – FGF – PDGF – TGF) Historical perspectives
4. Signal transduction pathways – G-protein coupled receptors – Tyrosine kinase pathway, mTOR, JAK-STAT pathway and TGF beta signaling
5. Tumour angiogenesis factors and inhibitors
6. Cancer stem cells and their therapeutic implications.

UNIT 3: Principles of carcinogenesis and tumor immunology (1+10+1)

1. Chemical carcinogenesis -Metabolism of carcinogenesis - Targets of chemical carcinogenesis
2. Principles of physical carcinogenesis – X-ray radiation – Mechanism of radiation carcinogenesis
3. Cancers induced by hormones
4. Oxidative stress and cancer
5. Mechanism of immune response to cancer
6. Role of gene rearrangement in tumor response
7. Heat shock proteins as regulators of immune response
8. Inflammation and cancer

9. Isolation and characterization of tumor derived antigenic peptides

UNIT 4: Molecular cell biology of cancer (1+10+1)

1. Proto-oncogenes and Oncogenes –discovery
2. Functional classes of oncogenes - oncogene activation
3. Cellular oncogene (c-onc) expression during normal embryonic development
4. Role of tumour suppressor genes in cancer
5. DNA repair and cancer (Xeroderma pigmentosum)
6. DNA methylation and cancer
7. Mechanisms of gene silencing – Antisense – Ribozymes – RNAi
8. Gene therapy for cancer
9. Personalized medicine and systems biology

UNIT 5: Cancer diagnosis and treatment (1+10+1)

1. Tumor markers
2. Gene expression microarray in individual cancer types
3. Proteomic methods in cancer diagnosis– 2D electrophoresis – Isotope-coded affinity tags – Mass spectrometry-based proteomics - Surface-enhanced laser desorption/ionization
4. Molecular imaging methods - Protein–Protein Interactions - Magnetic Resonance Spectroscopy - Ultrasound Imaging - Haplotype Mapping
5. Serum and urine analysis - cytogenetic analysis, cytologic and histologic diagnosis
6. Frozen section analysis – Immunohistochemistry
7. Molecular diagnostics - Southern blotting and PCR-based
8. Chemotherapy – types of drugs; modes of action of anticancer drugs, dosage and modes of administration, side effects
9. Immunotherapy and adoptive immunotherapy
10. Hormonal therapy - Stem cell therapy – Radiotherapy – Photodynamic therapy

11. Cancer prevention – Molecular mechanism of ageing and prevention – Diet and cancer prevention – Chemoprevention–Multiagent chemoprevention - Antioxidants – Protease inhibitors – Statins

Books for Study

1. Pelangaris S and Khan M., 2006. The Molecular Biology of Cancer, Blackwell Publishers
2. Margaret Knowles and Peter J Selby, 2005. Introduction to the cellular and molecular biology of cancer. (4th edition) Oxford University Press.
3. Weinberg Robert. , 2007. The Biology of Cancer, Garland Science, Taylor & Francis Group, New York
4. Hajmadi M., 2010. Introduction to cancer biology. 2nd edition
5. King RJB, Robins MW. , 2006. Cancer Biology. Harlow: Pearson Prentice Hall

Books for Reference

1. Ruddon R. W., 2006. Cancer Biology. , Fourth edition, Oxford University Press.
2. Kleinsmith L. J., 2004. Principles of Cancer Biology, Pearson Benjamin Cummings.
3. Morris D and Kearsley. J.1998. Cancer: A Comprehensive Clinical Guide, Taylor & Francis Group, New York.
4. Spillane J. B. and Henderson M.A., 2007. Cancer Stem cells: a review, ANZ J. Surg. 77: 464–468.
5. Ehrlich M., 2002. DNA Methylation in Cancer, Oncogene21: 5400-5413.

Websites

1. www.cancer.org
2. www.cancer.gov
3. www.icbp.nci.nih.gov

16PBT3ID01 PRINCIPLES OF FOOD PROCESSING

SEMESTER III CREDITS 5

CATEGORY MC(T) NO.OF HOURS/ WEEK 6

Objectives:

1. To impart the knowledge on the basic principles of food processing and the various methods used to process foods
2. To create an awareness of the processed food products available in the market.
3. To provide the basic principles of processing and the unit operations employed in a food processing plant – agro and livestock units.

Unit I: Introduction to food processing (1+12+2)

1. Background: Scope of food processing; historical developments - Source of food - food of plant; animal and microbial origin - different foods and groups of foods as raw materials for processing.
2. Unit operations in food processing – Size reduction; fluid-solid separation; filtration; membrane separation; drying and crystallization, storage, packaging
3. Food Safety: Introduction to food safety aspects and food related hazards – HACCP and ISO.

Unit II: Food preservation (3+14+3)

1. Processing and preservation by heat: blanching - pasteurization - sterilization and UHT processing - canning - extrusion cooking; dielectric heating - microwave heating - baking - roasting and frying - retort processing - hydrostatic pressure cooking etc.
2. Processing and preservation by low - temperature: refrigeration – freezing - CA - MA and dehydro - freezing.
3. Processing and preservation by drying - concentration and evaporation - types of dryers and their suitability for different food products - ultra – filtration - reverse osmosis.

4. Processing and preservation by non-thermal methods - irradiation - high pressure - pulsed electric field - hurdle technology.

Unit III: Application of enzymes and microbes (3+14+3)

1. Use and application of enzymes in processing and preservation of foods - Mechanisms of enzyme action in foods.
2. Food fermentations: Microbes of importance in food fermentations – Homo & hetero-fermentative bacteria; yeasts & fungi - Biochemistry of fermentations – pathways involved; Lactic acid bacteria fermentation and starter cultures - Alcoholic fermentations -Yeast fermentations - characteristics and strain selection; Fungal fermentations. Microbes associated with typical food fermentations- yoghurt; cheese; fermented milks – breads - idly - soy products; fermented vegetables and meats - pickling and smoking and food additives.

Unit IV: Plant product processing (3+14+3)

1. Cereals: Rice; Classification; physicochemical characteristics and thermal characteristics; Parboiling of rice - technology and effect on quality characteristics; Rice products - Flaked rice; Puffed rice; wheat - types and physicochemical characteristics; Malting; minor Millets and Breakfast cereals.
2. Pulses; Legumes; Nuts and Spices: Structure and composition of pulses; their importance in Indian diet; importance of legumes; milling and processing of Legumes; soy based products; cocoa processing and chocolate; Major and Minor Spices.
3. Principles and methods of fruit and vegetable preservation: composition and related quality factors for processing; Processing of fruit and vegetable products; Drying and dehydration of fruits and vegetables.
4. Oil seeds and fat processing - Basic processing of fats and oils and refining manufacturing and uses of shortening.

Unit V: Dairy and Livestock processing (3+9+3)

1. Meat and poultry processing: Factors affecting post-mortem changes in meat and poultry; Meat tenderization and preservation - aging; pickling; smoking. Dried and Cured meat. Canned meats.
2. Fish processing: Types of fish; composition; structure and spoilage factors of fish; Chilling of fish; Freezing and Individual quick freezing; canning and smoking operations.
3. Egg processing: Structure; composition; nutritive value; calculation of nutritive value and functional properties of eggs; Preservation and maintenance of eggs; Egg grading; egg powder processing - Preservation of Albumin and yolk-powder production.
4. Dairy processing: Milk collection; standardization; pasteurization; homogenization and membrane filtration; manufacturing of dairy products.

Books for Study

1. Fidel Toldraj, 2010. Handbook of Meat Processing, John Wiley & Sons.
2. Owens.M.Casey,Alvarado.Z.Christine and Sams. R.Alan, 2010. Poultry Meat Processing, Taylor & Francis Group,CRC Press

Books for References

1. Joseph Kerry, John Kerry and David Ledwood,2002.Meat Processing, Woodhead Publishing Limited, England (CRC Press).
2. P.S. Murano,2003. Understanding food science and technology, Thomson Wordsworth.

16PBT3TP01 SUMMER TRAINING PROGRAMME

SEMESTER III CREDITS 1
CATEGORY TP(P) NO.OF HOURS/ WEEK 3 – 4 WK

1. A staff member of a department (GUIDE) will be monitoring the performance of the candidate.
2. The summer training program falls between Semester II and III. Students are expected to undergo this training soon after the second semester examinations.
3. The training will commence not later than one week after the completion of the semester examination
4. Organizations for the summer placement must be confirmed before the commencement of the second continuous internal tests.
5. Students must submit letter of induction to the respective guide within the first week of the internship.
6. The student has to spend a total of 20 working days in the respective field.
7. Students are expected to submit weekly reports along with daily time sheets to the respective supervisors.
8. The reports will be used to evaluate the student's performance.
9. Students should submit a letter of completion from the organization duly signed by the authorities.
10. If the staff is satisfied with the performance of student, he/she will be marked "COMPLETED" at the end of the semester and the details will be submitted to COE office through the HOD

16PBT4PJ01 PROJECT

SEMESTER IV CREDITS 24
CATEGORY MC(T) NO.OF HOURS/ WEEK 30

Objectives:

1. To understand the purpose and importance of research in any field of Biotechnology.
2. To plan and carry out research work through literature review, materials and methods, results and discussion.

3. To present the findings periodically subjected to both external and internal evaluation.