PONDICHERRY UNIVERSITY

SCHOOL OF LIFE SCIENCE

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM AND SYLLABUS
M. Sc. BIOTECHNOLOGY
(2019 ONWARDS)
**PROGRAMME OBJECTIVE:**

Biotechnology is a multidisciplinary area on the educational scene and programmes have been developed to meet the growing demand for trained manpower for any meaningful Biotechnology activity in the country. The courses of the programme are designed to expose the students to recent exciting developments in the area of genetic engineering and biotechnology and their exploitation in industry, agriculture and medicine.

**PROGRAMME OUTCOME:**

By the end of the programme students will:

1) gain an in-depth understanding of the basic and recent development in the field of Biotechnology

2) Acquire skills of critical, analytical and problem solving in order to enable them to be successful in various national and international examinations,

3) acquires practical skills in handling the laboratory equipment and capable of independent thinking and in writing scientific proposal and presentation and

4) be capable of becoming successful academicians/researchers and/or entrepreneurs.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Code</th>
<th>Course Title</th>
<th>H/S</th>
<th>Credits</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester I</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.</td>
<td>BIOT 401</td>
<td>Basic Cell Biology</td>
<td>H</td>
<td>3</td>
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<td>2.</td>
<td>BIOT 402</td>
<td>General Microbiology</td>
<td>H</td>
<td>3</td>
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<td>3.</td>
<td>BIOT 414</td>
<td>Biochemistry</td>
<td>H</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>BIOT 415</td>
<td>Techniques in Biotechnology</td>
<td>H</td>
<td>3</td>
<td>5</td>
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<tr>
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<td>BIOT 521</td>
<td>Radiation Biology</td>
<td>S</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>6.</td>
<td>BIOT 403</td>
<td>Basic Cell Biology Lab</td>
<td>H</td>
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<tr>
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<td>BIOT 404</td>
<td>General Microbiology Lab</td>
<td>H</td>
<td>1</td>
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</tr>
<tr>
<td>8.</td>
<td>BIOT 464</td>
<td>Biochemistry Lab</td>
<td>H</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>9.</td>
<td>BIOT 465</td>
<td>Techniques in Biotechnology Lab</td>
<td>H</td>
<td>1</td>
<td>10</td>
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<tr>
<td>10.</td>
<td>BIOT 575</td>
<td>Radiation Biology Lab</td>
<td>S</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Semester II</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>11.</td>
<td>BIOT 421</td>
<td>Molecular Genetics</td>
<td>H</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>12.</td>
<td>BIOT 459</td>
<td>Molecular Immunology</td>
<td>H</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>13.</td>
<td>BIOT 425</td>
<td>Molecular Plant Breeding</td>
<td>H</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>14.</td>
<td>BIOT 484</td>
<td>Animal Biotechnology</td>
<td>H</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>15.</td>
<td>BIOT 416</td>
<td>Bioprocess Engineering and Technology</td>
<td>H</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>16.</td>
<td>BIOT 426</td>
<td>Stem Cell Biology</td>
<td>S</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>17.</td>
<td>BIOT 427</td>
<td>Environmental Biotechnology</td>
<td>S</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>18.</td>
<td>BIOT 471</td>
<td>Molecular Genetics Lab</td>
<td>H</td>
<td>1</td>
<td>20</td>
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<tr>
<td>19.</td>
<td>BIOT 460</td>
<td>Molecular Immunology Lab</td>
<td>H</td>
<td>1</td>
<td>21</td>
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<tr>
<td>20.</td>
<td>BIOT 475</td>
<td>Molecular Plant Breeding Lab</td>
<td>H</td>
<td>1</td>
<td>22</td>
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<tr>
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<td>BIOT 481</td>
<td>Animal Biotechnology Lab</td>
<td>H</td>
<td>1</td>
<td>23</td>
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<tr>
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<td>BIOT 466</td>
<td>Bioprocess Engineering and Technology Lab</td>
<td>H</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>23.</td>
<td>BIOT 476</td>
<td>Stem Cell Biology Lab</td>
<td>S</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Semester III</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>24.</td>
<td>BIOT 512</td>
<td>Genetic Engineering</td>
<td>H</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>25.</td>
<td>BIOT 514</td>
<td>Marine Biotechnology</td>
<td>H</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>26.</td>
<td>BIOT 477</td>
<td>Plant Biotechnology</td>
<td>H</td>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>27.</td>
<td>BIOT 523</td>
<td>Medical Biotechnology</td>
<td>H</td>
<td>3</td>
<td>29</td>
</tr>
<tr>
<td>28.</td>
<td>BIOT 482</td>
<td>Microbial Biotechnology</td>
<td>S</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>29.</td>
<td>BIOT 424</td>
<td>Immunotechnology</td>
<td>S</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>30.</td>
<td>BIOT 501</td>
<td>Applied Microbiology</td>
<td>S</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td>31.</td>
<td>BIOT 524</td>
<td>Proteomics and Genomics</td>
<td>S</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td>32.</td>
<td>BIOT 562</td>
<td>Genetic Engineering Lab</td>
<td>H</td>
<td>1</td>
<td>35</td>
</tr>
<tr>
<td>33.</td>
<td>BIOT 564</td>
<td>Marine Biotechnology Lab</td>
<td>H</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>34.</td>
<td>BIOT 566</td>
<td>Medical Biotechnology Lab</td>
<td>H</td>
<td>1</td>
<td>37</td>
</tr>
<tr>
<td>35.</td>
<td>BIOT 480</td>
<td>Microbial Biotechnology Lab</td>
<td>S</td>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td>36.</td>
<td>BIOT 474</td>
<td>Immunotechnology Lab</td>
<td>S</td>
<td>1</td>
<td>39</td>
</tr>
<tr>
<td>37.</td>
<td>BIOT 552</td>
<td>Applied Microbiology Lab</td>
<td>S</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>38.</td>
<td>BIOT 574</td>
<td>Proteomics and Genomics Lab</td>
<td>S</td>
<td>1</td>
<td>41</td>
</tr>
<tr>
<td>39.</td>
<td>BIOT 588</td>
<td>Project Phase I</td>
<td>H</td>
<td>2</td>
<td>-</td>
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<tr>
<td>Semester IV</td>
<td></td>
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</tr>
<tr>
<td>40.</td>
<td>BIOT 525</td>
<td>Pharmaceutical Biotechnology</td>
<td>S</td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td>41.</td>
<td>BIOT 526</td>
<td>Nanobiotechnology</td>
<td>S</td>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td>42.</td>
<td>BIOT 527</td>
<td>Biosafety, Bioethics and Bioentrepreneurship</td>
<td>S</td>
<td>2</td>
<td>44</td>
</tr>
<tr>
<td>43.</td>
<td>BIOT 577</td>
<td>Nanobiotechnology Lab</td>
<td>S</td>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>44.</td>
<td>BIOT 578</td>
<td>Pharmaceutical Biotechnology Lab</td>
<td>S</td>
<td>1</td>
<td>47</td>
</tr>
<tr>
<td>45.</td>
<td>BIOT 597</td>
<td>Credit Seminar</td>
<td>H</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>46.</td>
<td>BIOT 589</td>
<td>Project Phase II</td>
<td>H</td>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>

In addition, students are advised to choose “Physical Sciences for Biologists (CBIO 607)” and “Introduction to Bioinformatics (BINF 419)” as compulsory courses from Centre for Bioinformatics.
Course Objectives: To provide an overview of structural and functional aspects of cells and basic mechanisms underlying cell signalling and cell division.

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I  
Basic properties of cell, Major types of cell: Prokaryotic, animal and plant cell, their characteristics, cell wall, composition, function of bacterial cell wall. Plasma membrane, structure, function, fluid mosaic model, membranes, lipids and proteins transport across the membrane – passive and active.

UNIT II  
Endoplasmic reticulum, golgi complex – exocytosis; Lysosomes: phagocytosis, endocytosis, autophagy, Peroxisomes, Role of clatherin coated vesicles, Plant cell vacuoles; Structure of mitochondria and organization of respiratory chain; Structure of chloroplast and photophosphorylation; Structure of nucleus, nucleolus, nuclear membrane, transport across nuclear membrane.

UNIT III  
Molecular aspects of normal and cancer cell cell division: cell cycle stages, cyclins, cyclin dependent kinases (Cdks), Cdk inhibitors, transcription factors, tumor suppressors, checkpoints proteins, etc., cell death; apoptosis events and related proteins, necrosis and senescence.

UNIT IV  
Organic and inorganic constituents of cell: Water, minerals, polysaccharides, proteins, lipids, nucleic acid, vitamins and enzymes and their role(s) in cell function.

UNIT V  
Extracellular matrix, collagen, proteoglycans, fibronectin, laminins, integrins, selectin, cadherins, role of tight junctions and gap junctions, Signal transduction; cell signalling; cAMP, Role of G-proteins coupled receptors, Tyrosine kinases, etc.

References:


Course Outcome: Students will understand the fundamentals of cell biology and cell signalling.
Course Objective:
The main objective of “Microbiology” course is to introduce basic principles and applications. In order to provide fundamental knowledge to students, this course was designed to provide insights on microscopy, microbial diversity, nutrition, growth and host-interaction.

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

TEXT BOOKS

REFERENCES
4. Journal reviews and research articles.

Course Outcome: The students will understand the basics of microscopy, microbial diversity, nutrition, growth and host-interaction etc.
Course Objectives: The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I 7 h
Historical Basis and overview of Biochemistry, Biochemical basis of life, Biomolecules - Classification, Structure, Function and Significance of macromolecules – Carbohydrates, Proteins, Lipids and Nucleic Acids. Biomolecular hierarchy, Molecular assemblies and Molecular interactions in understanding cellular processes.

UNIT II 8 h
Enzymes – Nomenclature and classification of enzymes – protein & non-protein enzymes (ribozymes, DNAzymes); Mechanisms of enzyme action – specificity of enzyme action, single and multienzymes, isoenzymes, coenzymes and cofactor; Factors affecting enzyme activity-Michaelis-Menten Equation, Lineweaver-Burk Equation; Enzyme kinetics- single and multisubstrates; Enzymes inhibition- competitive, non-competitive, uncompetitive and allosteric inhibition; Enzyme Regulation and their relevance in metabolic pathways; Biological role of enzymes.

UNIT III 10 h

UNIT IV 10 h
Lipid Metabolism:Metabolism of Fatty acids - α,β,ω oxidation, fatty acid biosynthesis, saturated and unsaturated, endogenous synthesis of triacylglycerols, phospholipids, cerebrosides, gangliosides. Synthesis and degradation of cholesterol. Transport and storage of cholesterol. Arachidonic acid metabolism-Significance and synthesis of prostaglandins, leucotrienes and thromboxanes. Metabolic disorders associated with lipid metabolism.

UNIT V 10 h
Metabolism of proteins, nucleic acids and protein turnover- disposal of ammonia, urea cycle, non-protein aminoacids and amines and their role in cellular function; Metabolism of essential and non-essential amino acids- Purine and Pyrimidine biosynthesis and degradation, salvage pathways, regulation. Metabolic disorders associated with aminoacid and nucleotide metabolism.

Text Books:

References:

Course Outcome: Students would be able to: Gain fundamental knowledge in biochemistry; Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions to apply for translational research.
Course Objectives: To understand the principles and basics of all Instruments used in a biotechnology lab

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I 10 h

UNIT II 8 h

UNIT III 8 h
Centrifugation: Principle, types of centrifugation, description of the analytical and ultracentrifuge. Determination of molecular weight by sedimentation velocity method, separation of cell organelles and sarcolemma.

UNIT IV 9 h
Electrophoresis: Principle, types of electrophoresis, separation of serum proteins: (i) moving boundary electrophoresis, (ii) paper electrophoresis, (iii) starch gel electrophoresis, (iv) agar gel electrophoresis. Ag-Ab reaction – Immuno electrophoresis; DNA electrophoresis, DNA ladders, PFGE; Staining methods.

UNIT V 10 h

Text Books:

References:

Course Outcome: The students acquires the basic knowledge in handling of equipments and its principles
**Course Objectives:** This course addresses the biological effects of different radiations, free radical interactions in DNA at cellular and organism level. The details pertaining to utilization and mechanism of radiation both ionizing and non ionizing radiation leading to biological manifestations. As a result of nuclear fallout the different radiation syndromes and the recovery. The course addresses the DNA lesions associated with radiation damage, cataractogenesis and provides mechanistic details.

**Pre-requisite:** Bachelor’s level course in Life Sciences, Physics & Chemistry.

**Unit I**
9 h

**Unit II**
9 h

**Unit III**
9 h
Acute radiation effects of whole body irradiation, late somatic effects, effect on the immune responses, LD50, radiation syndrome, bone marrow, gastrointestinal and cerebrovascular acute radiation syndrome, Leukemia and other cancer, Radiation cataractogenesis, Dose response relationship in model normal tissue. Effect of radiation on Embryo and Foetus.

**Unit IV**
9 h
Radiation damage to DNA, RNA and proteins. DNA strand breaks, Chromosomal aberrations, Methods of detecting the damage caused by ionizing radiation and UV radiations. DNA cluster damage. DNA damage caused by heavy ionizing radiations. DNA repair mechanisms and Xenoderma Pigmentosum, Ataxia Telengiectasia disorders

**Unit V**
9 h
Radiation Carcinogenesis, biology and exploitation of tumor hypoxia, heritable effects of radiations, chemotherapeutic agents, Effect of non-ionizing radiations, ultrasound, optical radiations, microwave radiations.

**Text Book**

**Reference:**

**Course Outcome:** The students will develop interest in the radiation utilization for the cold sterilisation and value addition. The development of procedures for effective radiolysis. The Govt of India and also in many countries the radiation biology and radiation physics for effective usage is feasible and the students could use for entrepreneurship by quantifying the radiation dose and standardization for raw and processed food materials by cold sterilisation.
1. Culturing of various cancerous cell lines.
2. Observation of eukaryotic cancer cell lines under microscope; live, dead, starved, etc. and staining methods; trypan blue and DAPI, etc.
3. Observation of drug induced differentiation process of K562 leukemic cell lines
4. Observation of drug induced apoptosis process of cancerous cell lines
5. Overexpression of desired protein with fluorescence tag in eukaryotic cells; transfection and fluorescence microscopy.
6. Isolation of genomic DNA, RNA and proteins from eukaryotic cell lines and detection methods; OD, agarose gel, western blotting, staining of SDS –PAGE gels, etc.
7. Isolation of mono nuclear and RBC from peripheral blood samples.
8. Preparation of bacterial competent cell by calcium chloride method.

Suggested Reading:

BIOT 404  GENRAL MICROBIOLOGY LAB  CREDIT: 1
30 h

1. Microbial isolation techniques. Isolation of bacteria and fungi
2. Establishment of pure cultures - streak, pour and spread plating techniques
3. Identification of microbes. Simple, differential, negative staining and spore staining methods.
4. Establishment of bacterial growth curve
5. Bacteriophage plaque assay to enumerate phage titer.
6. Test for in vitro antibiosis
7. Screening of microbes for the production of enzymes and hormones
8. Biochemical and genetic fingerprinting of microbes
9. Phylogenetic analysis of microbes
10. Microbial preservation techniques- patch plate, slant, water stock, glycerol stock and lyophilization.

Suggested Reading:

1. Qualitative analysis of Simple sugars and Carbohydrates.
2. Qualitative analysis of Amino acids and Proteins.
3. Isolation / Extraction of biochemical metabolites (Carbohydrates, Protein and Lipids) from various tissues (plant & animals).
4. Estimation of glucose by Benedict's method.
5. Estimation of protein by Lowry’s/Bradford’s method.
7. Estimation of enzyme activity. (salivary amylase/LDH)
9. Estimation of ascorbic acid/Tocopherol
10. Assay of enzyme/hormone by ELISA.

**Suggested Reading:**

1. Buffer Preparation: Determination of $pK_a$
2. Spectrophotometry: Determination of $\lambda_{max}$
3. Centrifugation: High speed centrifugation, density gradient centrifugation
4. Chromatography: IEC / Adsorption / GFC for purification of an enzyme
5. Electrophoresis: Agarose and SDS - PAGE
6. FTIR, ESR & NMR
7. Biological applications of radioisotopes: $^3$H labeling of liver tissue
8. Polymerase Chain Reaction.
9. Real-time PCR (Demonstration)

Suggested Reading:


1. Fricke’s dosimetry for calculating the dose rate of gamma-rays and comparing it with source.
2. Agarose gel electrophoresis of gamma-irradiated plasmid DNA.
3. Determination of death rate of the gamma-irradiated bacterial cells.
4. Calculation of seedling injury in irradiated seedlings with different doses of radiation.
5. Effect of dose rate on the seedling injury for a given dose of radiation.
6. Identification of chromosomal damage in the root tips as a result of gamma irradiation.
7. Determination of catalase activity in plant seedlings irradiated with various doses of gamma-irradiation.
8. Effect of electron scavengers on post-irradiation treatment of the seeds
9. Determination of total peroxides obtained after various treatments in 7-day old seedlings.
10. FT-IR spectroscopic investigations on the gamma-irradiated biological materials

Suggested Reading:

**Course Objectives:** The course aims to provide students a basic understanding on (i) Genome organization of Prokaryotes and Eukaryotes, (ii) Mendelian and Non-Mendelian Genetics (iii) DNA Replication, Transcription & Translation, (iv) DNA repair mechanisms and (v) Regulation of gene expression.

**Pre-requisite:** Master level courses in Biochemistry, Cell Biology and Microbiology

UNIT I  
Mendelian inheritance, Non-Mendelian inheritance, Sex linked inheritance, Experimental evidences for DNA as the genetic material, Organization of prokaryotic and eukaryotic genome, DNA supercoiling, Chromatin organization-histone and DNA interactomes.

UNIT II  
Structure and assembly of prokaryotic and eukaryotic DNA polymerases, Experimental evidences for the semi conservative nature of replication, DNA replication mechanisms, Accessory proteins for the DNA replication, Regulation of replication initiation in prokaryotes and eukaryotes.

UNIT III  
Mechanism of transcription in prokaryotes and eukaryotes - RNA polymerases, Promoters and Enhancers, Transcriptional initiation, elongation and termination processes. Post-transcriptional processing events – capping, splicing of introns and polyadenylation, Processing of Pre-ribosomal RNA and the assembly of ribosomes, Structure and the maturation of tRNAs.

UNIT IV  
Genetic code, degeneracy of codons, Wobble hypothesis, codon bias, Mechanism and fidelity of amino acyl tRNAsynthetases, Mechanism of Translation – initiation, elongation and termination, Post-translational modifications, Antibiotics that target translation, Selenocysteine and Pyrrolysine.

UNIT V  
Regulation of gene expression in prokaryotes – Operon concept, lac and trp operon, positive and negative regulation of lac operon. Transcriptional attenuation of Trp operon, Regulation of gene expression in eukaryotes by chromatin structure - epigenetic modifications of chromatin-Writers, Readers and Erasers. Role of DNA methylation and histone modifications in the regulation of gene expression.

UNIT IV  
Spontaneous and Induced mutations, DNA repair pathways – Mismatch repair, Base excision repair, Nucleotide excision repair, Non homologous end joining pathway and Recombinational repair.

References:


**Course Outcome:** By the end of the course, the students will acquire the knowledge and thorough understanding on genome organization, concept of non-mendelian genetics and the major molecular information pathways and processes of the prokaryotic and eukaryotic cells.
Course Objectives: The course aim to understand fundamentals of immunology, Major components of Immune response and aim to study the Translational research aspects like Clinical immunology, vaccines and cancer immunotherapy.

UNIT I: Fundamental concepts and overview of the immune system  5h
Overview and Concepts, Components of innate and acquired immunity; phagocytosis; complemen and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); inflammatory response; mucosal immunity; antigens: immunogens and haptens.

UNIT II: Components of Immunity  5h
Cells and Tissues of the Immune system: Different lineages. Organs of immune system, Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness & disease susceptibility.

UNIT III: Immune Responses generated by B and T lymphocytes  10h
Structure and classes of Immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Signal transduction in lymphocytes; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity. T-cell maturation, activation and differentiation and T-cell receptors; functional T cell subsets; cell-mediated immune responses, ADCC; Cytokines and their therapeutic uses; Antigen processing and presentation- endogenous and exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

UNIT IV: Antigen-antibody Interactions  10h
Precipitation, agglutination and complement mediated immune reactions; Immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, FACS, immunofluorescence microscopy and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand-receptor interaction; Memory and Death in Immune System. CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

UNIT V: Clinical Immunology and Vaccines  15h
Immunity to infection: bacteria, viral, fungal and parasitic infections (with e. g. from each group); co-evolution of microbes and host immune systems; hypersensitivity: Type I-IV; autoimmunity: types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC & TCR in autoimmunity; MHC genes and their role in autoimmune and infectious diseases, treatment of autoimmune diseases; HLA typing; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; Tumor immunology and Cancer immunotherapy. Recombinant DNA vaccines; antibody genes and antibody engineering: Chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine and therapeutic vaccine. Immunodeficiency, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Text Books:
References:


Course Outcome: Students will acquire knowledge on fundamentals of immunology, major components of immune response; gain knowledge in translational research aspects like clinical immunology, vaccines and cancer immunotherapy.
Course Objectives: To understand the Fundamentals and application breeding and molecular plant breeding methods for crop improvement

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I  8 h
Plant breeding- History; Genetic resources- centres of diversity and origin of crop plants, Law of homologous variation, genetics resources

UNIT II  10 h
Mode of reproduction in plant: Principles and methods of breeding self, cross pollinated and vegetatively propagated plants, Heterosis breeding, Polyploidy and haploids in breeding, Wide hybridization, Mutation breeding, Breeding crops to contain useful and adaptive traits; seed production and variety development and its conservation.

UNIT III  7 h
Plant genome mapping: Types of mapping population; RFLP and AFLP mapping. Marker assisted breeding using RFLP, AFLP, RAPD, SNP and CAPS marker.

UNIT IV  10 h
Plant tissue culture and somatic cell genetics – role of growth regulators, Micropropagation, Germplasm storage in vitro; Embryo rescue, Haploids and triploids, Secondary products, Protoplast culture and fusion, Cybrids, Somaclonal variation, Mutant selection in vitro and by transposon tagging.

UNIT V  10 h
Plant genetic engineering using recombinant DNA techniques: Genetic engineering for abiotic stress, quality improvement; Strategies for Marker Gene Removal from Transgenic plants; Transgene silencing, Strategies to avoid gene silencing and improve gene expression in transgenic plants, Description and uses of antisense RNA, ribozymes in plants; Gene editing by CRISPR-Cas technology, Ethics and plant genetic engineering.

Text Books:

References:

Course Outcome: The students will acquire the knowledge on Fundamentals and application breeding and molecular plant breeding methods for crop improvement
Course Objectives: The students will learn about basics function of Animal Cell Culture application, production of transgenic animals, Animal diseases and Biotechnology in animal production

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I 10 h
Animal Cell culture primary and established cell line cultures, functions of different constituents of culture media, serum and protein free media and their applications, scaling up of animal cell culture, cell synchronization, cell cloning and micro manipulation. Organ and histotypic culture. Application of animal cell culture for virus application and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture. Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II 10 h

UNIT III 10 h

UNIT IV 8 h
RFLP, RAPD and its applications in domestic animals. Molecular diagnostics of pathogens in animals. Detection of meat adulteration using DNA based methods. Biotechnological approaches to vaccine production Development of animal vaccines for Reinderpest, foot and mouth disease, blue tongue disease, rables and anthrax. Peptide vaccines, fusion protein vaccines, synthetic peptide vaccines, anti-idotype antibody vaccines.

UNIT V 7 h
Biotechnology in animal production-manipulation of growth using hormones and probiotics, manipulation of lactation, manipulation of wool growth in sheep and rabbits. Ethical issues in animal biotechnology: animal usage, CPCSEA and IAEC guidelines, Management aspects of biotechnology and genetic engineering.

Text Books:
2. Gordon (2005) Reproductive techniques in Farm Animals,Oxford CAB International

References:

Course Outcome: the students will know about basics function of Animal Cell Culture application, production of transgenic animals, Animal diseases and Biotechnology in animal production
**Course Objectives:** Bioprocess Technology is a course that offers real solutions for the problems of food, medicine, and fuels. The models of microbial growth, the Design, Principles of fluid mechanics, gas–liquid mass transfer Lab fermentor to large scale fermentation and dynamics a special case study of the fermentation of penicillin, beer with special reference to downstream processing.

**Pre-requisite:** Bachelor’s level course in Life Sciences, physics and chemistry

**UNIT I**
Fermented foods and beverages, food ingredients and additives prepared by fermentation, fermentation as a method of preparing and preserving foods, microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products, process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products, bacteriocins from lactic acid bacteria, production and applications in food preservation, biofuels and biorefinery. Isolation, screening and maintenance of industrially important microbes, strain improvement for increased yield and other desirable characteristics, preservation- history.

**UNIT II**
Mechanism of enzymatic reactions, Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions and applications in starch and sugar conversion processes, preparation of high-fructose corn syrup, hydrolyzed protein, baking by amylases, deoxygenation and desugaring by glucose oxidase, beer mashing and chill proofing, cheese making by proteases and various other enzyme catalytic actions in food processing, large scale animal and plant cell cultivation, fermentation economics.

**UNIT III**
Microbial growth kinetics and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms), Monod model, batch culture, Elemental balance equations, metabolic coupling – ATP and NAD+, yield coefficients, unstructured models of microbial growth, structured models of microbial growth, Batch and continuous fermenters, modifying batch and continuous reactors, chemostat with recycle, multistage chemostat systems, fed-batch operations, conventional fermentation v/s biotransformation, media formulation and optimization, sterilization, aeration, agitation and heat transfer in bioprocess, scale up and scale down measurement and control of bioprocess parameters

**UNIT IV**
Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packedbed, bubble column fluidized trickle bed, immobilization of cell systems. Aseptic, septic and anaerobic fermentors

**UNIT V**
Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products,liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging

**Text Books:**

**Course Outcome:** The students will understand to determination of titer and identification of suitable strain for utilisation purpose. Working with low volumes, Microbial growth kinetics, Preparation of complex media, industrial operations for preparation of Beer, baking, large scale fermentation, different downstream processing methods for product purifications.
Course Objectives: To understand the basics of stem cell, types of stem cells, identification, isolation and applications.

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I 10 h
Introduction to stem cells – Definition, History, Types and Sources of stem cells. Capacity of stem cells-Totipotent, Pluripotent, Multipotent, Unipotent. Embryonic stem cells and Adult Stem cells-Mesenchymal stem cell, Neuronal stem cell, Gut Epithelial stem cells, Hematopoietic stem cells; Bone marrow, Peripheral blood and Cord blood stem cells, Cancer stem cells. Stem cell niche/microenvironment. Stem cell cryopreservation.

UNIT II 10 h
Properties- Self-renewal and Differentiation. Regulation of stem cell: Cell cycle regulation, Gene expression, Chromatin modifications, Epigenetic regulation (DNA and Histone Methylation and Histone Acetylation, etc.), and miRNA roles. Cross talk between miRNAs and epigenetic regulators during stem cell differentiation.

UNIT III 10 h

UNIT IV 10 h

UNIT V 5 h
Ethical issues associated with stem cell research. Implication of human embryonic stem cell research, societal implications: religious vs. scientific views. Ethical guidelines for stem cell research (National (ICMR-DBT) & International).

Text Books:

References:

Course Outcome: The students acquire knowledge over basics of stem cells and its applications.
Course Objectives: The students will understand the impact of pollution on the environment and the need for remediation with the use of microbes and biological methods and they also learn about the biorenewal fuels.

Pre-requisite: Bachelor’s level course in Life Sciences

Unit I Introduction to environment 8 h
Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II Bioremediation 7 h
Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ).

Unit III Role of microorganisms in bioremediation 8 h
Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Unit IV Biotechnology and agriculture 11 h
Bio insecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic medications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, Pseudomonas fluorescens); Biofertilizers: Symbiosystems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi-symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

Unit V Biofuels 11 h
Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

Textbooks and References:

Course Outcome: The student acquires the knowledge over nature of pollution, and basic of bioremediation and biofuels.
1. Electrocompetent cell preparation.
2. Transformation of *E. coli* by electroporation.
3. Transformation of *S. cerevisiae*.
4. Mating of *S. cerevisiae*.
5. Genomic DNA isolation from mammalian cells/tissue.
6. Total RNA isolation from mammalian cells/tissue.
7. Quantification of gene expression by quantitative RT-PCR.
8. Histone extraction from mammalian cells.
9. SDS-PAGE analysis of histones.

**Suggested Reading:**

1. Immunization and generation of Anti-sera in rabbit against antigen
2. Microscopic analysis of immune cells by Giemsa stain
3. Separation of immunoglobulin G fractions using affinity chromatography
4. Diffusion methods of Immunoelectrophoresis
5. Rocket electrophoresis
6. Titer value determination
7. ELISA for detection of Antigens/Antibodies
8. Blood group mapping
9. Separation of mononuclear cells by Ficoll-hypac method and their cryopreservation
10. Demonstration of FACS

Suggested Reading:

1. Immunochemical Protocols, Editors: Burns, Robert (Ed.) Humana Press Springer Inc., 2005

1. General Breeding Techniques: Emasculation, pollination and tagging.
2. Selection of parents for hybridization and embryo rescue.
3. Tissue culture techniques: Preparation of various tissue culture media.
4. Tissue culture of explants.
5. Isolation and culture of protoplasts.
6. Isolation and culture of microspores.
7. Application of RFLP technique in plant breeding.
8. Demonstration of AFLP technique in plant breeding.
9. Detection of multiple genes by employing SNP primers.

Suggested Reading:

1. Animal cell culture.
2. Protein profile of silk gland and haemolymph of larval forms of silk worm.
3. Morphology of male gametes of different animals—bull, goat and sheep: Cryopreservation of gametes of bull.
4. *In vitro* fertilization of fish and hatching.
5. Gene transfer in animal cells—Electroporation.
6. Biopesticide effect on mosquito larvae.
7. Identification and partial characterization of Lactic Acid Bacteria.
8. Field visit to semen bank.
9. Field visit to silk worm rearing.

**Suggested Reading:**

1. Microbial culture streaking from frozen vial to agar plate
2. Preparation of inoculum and growth kinetics of microbes
3. Whole cell immobilization of microbes and media utilization studies
5. Isolation of microorganisms from soil samples.
6. Assembly of bioreactor and sterilization.
7. Microfiltrations and separation of cells from broth by vacuum method.
8. Demonstration of analytical techniques HPLC
9. Demonstration of GC-MS spectroscopy

**Suggested Reading:**

1. Isolation of mononuclear cells from blood sample.
2. Isolation of Hematopoietic stem cells (CD34+) from peripheral and cord blood.
3. Isolation of Mesenchymal stem cell from cord blood.
5. Maintenance of Hematopoietic stem cells.
6. Culture of hematopoietic CD34+ cells.
7. Nuclear transfection of CD34+ cells.
8. Functional assays of Hematopoietic stem cells (CAFC&CFC).

**Suggested Reading:**

Course Objectives: The course aims to provide students a thorough understanding on various vectors, different cloning strategies and selection methods, mutagenesis strategies, genomic and cDNA library construction methods and applications of genetic engineering in different disciplines.

Pre-requisite: Master level course in Molecular genetics, Biochemistry & Cell Biology

UNIT I  6 h
Polymerase Chain Reaction, guidelines for PCR Primer design, degenerate and specific primers, PCR optimization strategies, co-solvents in PCR. Different types of PCR: Hot Start PCR, AP-PCR, Nested PCR, Error-prone PCR and Touch down PCR, Quantitative real time PCR: Principle and Probe chemistry.

UNIT II 8 h

UNIT III 10 h

UNIT IV 6 h

UNIT V 10 h
Mammalian expression vectors, Transient transfection and stable transfection, Viral vectors for mammalian cells, Gene therapy, Generation of knock-out and knock-in mouse, Vectors for higher plants, Agrobacterium mediated transformation, Removal of marker genes, Applications of plant biotechnology: Insect resistance, herbicide resistance and delaying of fruit ripening. Terminator seed technology.

UNIT VI 5 h
Application of DNA technologies in Forensic sciences, siRNA and miRNA mediated knock down. Genome engineering technologies: Zinc finger nucleases, TALENS and CRISPR-Cas9 technology.

References:

Course Outcome: By the end of the course, the students will acquire the knowledge and thorough understanding on different types of vectors and various methods of recombinant DNA technology.
**Course Objectives:** The course aims to understand the knowledge on Marine organisms, Marine hydro colloids, applications of Genetic engineering, extraction of Marine Bioactive Compounds and extremophile.

**Pre-requisite:** Master level course in Molecular Biology and Animal Biotechnology

**UNIT I**

**UNIT II**

**UNIT III**

**UNIT IV**
Production of transgenic fishes. Growth hormone, antifreeze protein, disease resistant fish, application of hormones in induced breeding in aquaculture. Antifreeze protein and its applications.

**UNIT V**
Pharmaceuticals from marine realms, type of drugs from marine organisms and their medical applications. Biofouling and their control. Marine bioremediation- Biosurfactants and Control of oil spills. Extremophiles

**Text Books:**

**References:**

**Course Outcome:** The students acquires the knowledge on Marine organisms, Marine hydro colloids, applications of Genetic engineering, extraction of Marine Bioactive Compounds and extremophile.
Course Objectives: The objective of “Plant Biotechnology” course is to provide fundamental knowledge on modern plant molecular biology and processes, including plant genome organization, protein targeting into organelles, tissue-specific gene expression, transposons, transformation cassettes, gene transfer tools and genetic engineering.

Pre-requisite: Master level course in Molecular biology

UNIT I 10 h
Genome organization and protein targeting: General organization of nuclear, mitochondrial and chloroplast genome. Targeting of proteins synthesized in cytoplasm to chloroplast, mitochondria and within the endomembrane system of plants.

UNIT II 10 h

UNIT III 7 h
Development of plant transformation cassettes: Structure and function of Ti plasmid of Agrobacterium, Mechanism of T-DNA transfer to plants. Ti plasmid vectors for plant transformation. Promoter and marker genes in plant transformation. Criticisms regarding the use of different promoters and markers.

UNIT IV 8 h
Gene transfer and tissue culture techniques: Physical, chemical and biological methods for plant gene transfer. Shoot-tip culture, Rapid clonal propagation, Somoclonal variation and synthetic or artificial seeds, cytoplasmic male sterility.

UNIT V 10 h
Transgenic plants for virus resistance, herbicide tolerance, delay of fruit ripening, resistance to insect, fungi and bacteria. Production of antibodies, viral antigens and peptide hormones in plants.

Text Books:

References:

Course Outcome: The students understand the application of genetic engineering in plants, transgenic plants as well as tissue culture.
**Course Objectives:** Students will acquire knowledge on drug discovery & development, molecular diagnostics, newer therapeutics, vaccines and vaccine technology.

**Pre-requisite:** Master level course in Microbiology and Immunology

**UNIT I Drug discovery and Development**

10 h

**UNIT II Molecular Diagnostics**

5 h
Biosensors in clinical diagnosis, Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Nanotechnology in diagnosis.

**UNIT III Modern Therapeutics**

10 h
Stem cells in therapy, Gene Therapy: basic approaches to gene therapy, vectors used in gene therapy, applications of gene therapy in cancer, genetic disorders and AIDS. Therapeutic proteins, interleukins, interferons – principle, production and applications. Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin. Nutraceuticals- Food derived bioactive peptides, production of single cell protein. Chiral technology - Principle and applications

**UNIT IV Vaccines and Vaccine Technologies**

10 h

**UNIT V Clinical trials and Licensing**

10 h
Clinical trials: Phase I, Phase II, Phase III and Phase IV trail norms, ICMR guidelines for design and conducting clinical trials, licensing procedure in India, intellectual Property Rights and patents in biotechnology.

**Text Books:**

**References:**
1. Marks AR &Neil US. Textbook of Molecular Medicine - Science in Medicine, Jones and Bartlett Learning, New Delhi; 2010.

**Course Outcome:** The students understand the concept of drug discovery & development, molecular diagnostics, newer therapeutics, vaccines and vaccine technology.
Course Objectives: Students are exposed to & sensitized on the importance of microbes & their various biotechnological applications including antibiotics, biopolymers, bioplastics, food, feed, colorants, biopulping, biobleaching, biocide control, biopesticides, biofertilizers, bioremediation, bioconversion, biofuels, waste water treatment, degradation of xenobiotics, etc.

Pre-requisite: Master level course in Microbiology and Genetic Engineering

UNIT I
General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds. Genetic engineering of microbes to improve production of antibiotics, amino acids, lipids, enzymes, steroids and secondary metabolites. Biopolymers and bioplastics

UNIT II
Definition, Concepts- history, biotechnological potentials of microalgae – food, feed Colourant, fuel and pharmaceutically valuable compounds. Cultivation methods of algae with reference to Dunaliella. Production of microbial biofertilizers cyanobacteria, Rhizobium, Azotobacter, Azospirillum, Phosphobacteria and VAM.

UNIT III

UNIT IV

UNIT V

Text Books:

References:


**Course Outcome:** The students will understand the detailed application of micro organisms and Mushroom cultivation as additional income generation activity, bioconversion of agroresidues to useful products, isolation & screening of antibiotic producing microbes may help in finding new drugs in clinical labs, use of green technologies such as biopulping, biobleaching and biofuels.
BIOT 424  IMMUNOTECHNOLOGY  CREDITS: 3

Course Objectives: The students will acquire knowledge on immunochemical methods and protocols, methods involved in antibody production and antibody engineering.

Pre-requisite: Master level course in Immunology

UNIT I  8 h
Introduction Scope of Immunotechnology, Kinetics of immune response, memory; Preparation and purification of Antigens, Extraction of antigens from pathogens, parasites and other biological materials. Antigen fractionation and purification. Preparation of synthetic antigens, Recombinant antigens.

UNIT II  6 h
Principles of Immunization, different kinds of Immunization procedures; Techniques for analysis of Immune response. Production, purification and characterization of antibodies. Purification of Immunoglobulins, Characterization of Immunoglobulins.

UNIT III  10 h
Hybridoma and monoclonal antibody (MAb) techniques, Production of murine hybridoma, Production of MAb in cultures and animal (Ascites), Purification of MCAb. Characterization of MAb and Labelling of antibodies Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes.

UNIT IV  11 h
Cellular immunological methods, CD nomenclature, Markers of immune cells, Separation and purification of immunocompetent cells. Flow cytometry and FACS, Functional tests for immunocompetent cells, Cytokine expression assays; Cell cloning and reporter assays and Histocompatibility testing.

UNIT V  10 h
Immunological assays; Agglutination tests, Complement fixation tests, In vivo tests, Neutralization tests, Radioimmunoassays, Enzyme immunoassays, ELISPOT assay, Immunoblotting, Immunohistochemistry and immunohistopathology and Immunofluorescence techniques.

Text books:

References:

Course Outcome: The student will understand the concepts and immunochemical protocols, methods involved in antibody production and antibody engineering.
Course Objectives: The student will understand the elaborated application of microorganism in fermentation, industrial process using microbes for production of alcohol, lactic acids, organic acids, antibiotics and therapeutic and diagnostic proteins

Pre-requisite: Master level course in Microbiology and Molecular Biology

UNIT I
10 h

UNIT II
10 h
Production of beverage and industrial alcohols, wine, beer. Production of organic acids - lactic acid, acetone-butanol, citric acid and acetic acid. Production of microbial biomass – SCP.

UNIT III
10 h
Industrial Production of antibiotics- Penicillin, erythromycin and streptomycin; Bacterial production of enzymes-protease, cellulase, amylase, glucose isomerase, etc. Immobilization of enzymes and development of biosensors.

UNIT IV
8 h
Role of Microorganisms in cheese production – cheddar cheese, blue cheese, Swiss cheese, camembert cheese, yogurt, buttermilk, sour cream, koumiss, kefir manufacturing. Leather processing.

UNIT V
7 h
Production of therapeutic and diagnostic proteins – Interferon, somatotropin, cytokines, insulin, growth factors and steroids. Microbial leaching of ores.

Text Books:
2. Glick BR and Pasternak JJ. Molecular Biotechnology - Principles & applications of Recombinant DNA. ASM Press, 2009

References:

Course Outcome: The students acquired the knowledge over various use of microbes in industries and the its production.
Course Objectives: The student will understand the important aspects of proteomics and genomics which are the backbone of biotechnology.

Pre-requisite: Bachelor’s level course in Life Sciences/ Chemical Sciences

UNIT I
Whole genome analysis: Prokaryotes and Eukaryotes, Foundations of genomics. Mapping of genome – linkage mapping, High resolution physical mapping – Marker associated and clone assisted genome mapping: Genome library construction – YAC, BAC and PAC libraries of genome.

UNIT II
Genome sequencing – Hierarchical and shot gun sequencing methods – variation in sequencing methods – Pyrosequencing – Automation in genome sequencing – Sequence analysis – Databanks – Data mining.

UNIT III

UNIT IV

UNIT V

Text Books:

References:

Course Outcome: The students acquire the knowledge on genomics and proteomics analysis method and its application in various field researches. An insight into whole genome proteomics would enable them to modify technologies provided in the course.
1. PCR amplification of mammalian gene and purification of PCR product.
2. Estimation of PCR product concentration and purity by UV spectrophotometer.
3. Restriction digestion of the DNA and purification.
4. Ligation and transformation.
5. Screening of transformants by colony PCR.
6. Isolation of recombinant plasmid from positive transformants.
7. Confirmation of the cloning by double digestion of recombinant plasmid.
8. Transfection of the recombinant plasmid in HEK293 cells.
10. Analysis of the protein expression by western blotting.

**Suggested Reading:**

1. Estimation of water quality parameters in Sea Water (Dissolved Oxygen, Salinity Ammonia and Nitrates)
2. Identification and partial characterization of fish bacterial pathogen
3. PCR detection of White Spot Virus or Monodon BaculoVirus in shrimps
4. Production and characterization of Marine protease
5. Production and characterization of Marine lipase
6. Production and characterization of Marine carotenoids
7. Enrichment of live feed organisms – Artemia
8. Field visit to shrimp hatchery, farms, diagnostic laboratory and salt pans

Suggested Reading:

3. Practical Handbook of Estuarine and Marine Pollution M.J.Kennish 1996 CRC marine Science
1. Identification and characterization of selected medically important pathogens – *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Acinetobacter baumannii*

2. Culturing of single cell protein (SCP) (Spirullina)

3. Ammonium sulfate precipitation of parasite (cystic sacrosis) antigen

4. Quality control of antibodies – HPLC

5. Introduction and use of various genome databases.

6. Similarity searches using tools like BLAST and interpretation of results

7. Multiple Sequence alignment using ClustalW

8. Phylogenetic analysis of protein and nucleotide (16S) sequences

9. Role of bioinformatics in drug development computer assisted drug designing and computer based ligand and Receptor interaction

10. Genetic and biochemical analysis of novel molecules

**Suggested Reading:**

1. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten. Medical Biotechnology, ASM Press. 2014
1. Production of Taq polymerase using recombinant *E. coli*
2. Mushroom cultivation
3. Different methods of antimicrobial susceptibility testing
4. Isolation of antagonistic bacteria for growth suppression of pathogens
5. Isolation and characterization of Nitrogen fixers
6. Microbial bioconversion of agricultural wastes using fungi and/or bacteria
7. Microbial degradation agricultural pollutants, fungicides and insecticides
8. Cultivation and mass multiplication of *Azolla*

**Suggested Reading:**

1. Preparation of antigens from pathogens and parasites
2. Slide and Tube agglutination reaction
3. Immunofluorescence technique
4. Separation of mononuclear cells by Ficoll-Hypaque
5. SDS-PAGE and Immunoblotting
6. Rapid detection of HBV/ HCV candidate antigens and Diagnostic PCR
7. Demonstration of Phagocytosis of latex beads
8. Separation of CD cells using Flow cytometry
9. Isolation and Identification of lymphocytes and their subsets
10. Immunodiagnostics using commercial kits

**Suggested Reading:**

1. Immunochemical Protocols, Editors: Burns, Robert (Ed.) Humana Press Springer Inc., 2005
1. Estimation of Microbial biomass
2. Red and White wine fermentation/Alcohol production from molasses using yeast
3. Production of amylase using bacillus under submerged conditions
4. Production of protease using Protease vulgaris under submerged conditions
5. Production of protease using rice bran / Cottage cheese production
6. Production of penicillin-G
7. Mass culture of LAB in fermentor
8. Industrial visit to brewery and distillery

**Suggested Reading:**

1. One and two dimensional separation of protein
2. Scanning and image analysis of 2D gels and spectral analysis of proteins.
3. Computer assisted demonstration of microarray technology: DNA and protein.
4. Liposome preparation
5. Identification of cystic fibrosis gene from Human genome and fatty acyl desaturase gene in Arabidopsis genome.
6. Characterization of the protein coded by gene sequence above (in Expt 4) using NCBI software online.
7. Primer designing methods: degenerate and specific oligonucleotide primers.

**Suggested Reading:**

**Course Objectives:** The course will give a broad overview of basic pharmacology and extensive overview of research and development carried out in industrial setup towards drug discovery and development

**Pre-requisite:** Bachelor’s level course in Life Sciences/Biochemistry

**UNIT I**

9 h

Introduction to Pharmacology- History, nature and source of drugs, Classification of drugs, Dosage forms (liquid & solid dosage forms, Topical applications and aerosols), routes of drug administration-types, advantages and disadvantages, site of action of drugs, Combined effect of drugs, Factors modifying drug action, tolerance and dependence, Mechanism of action of drugs, drug interactions, Adverse Drug Reactions.

**UNIT II**

10 h

Principles of Basic and Clinical pharmacokinetics- Models of pharmacokinetics, Transmembrane transport of drugs. Drug absorption pathway; Bioavailability of drugs-definition, factors influencing bioavailability; Fate of Drug - Drug metabolizing enzymes (hepatic drug enzymes and cytochrome P450), Excretion of drug-types, models of elimination and mechanism. Biological half-life of Drugs, Bioassays and Therapeutic Drug Monitoring, Drug accumulation in continuous medication. Application of drug plasma concentration monitoring.

**UNIT III**

10 h

Hit to Lead Optimisation by Preclinical Studies & Clinical Trials- Approaches to screen lead molecules-Irrational Approach, Rational approach, Anti sense Approach, High Throughput Screening, Sources of lead molecules, including natural products, synthetic libraries, and in silico structure-based molecules, Prodrugs, Chiral Drugs, Vaccines, Antibodies, Cytokines, Hormones, gene therapy. Preclinical Toxicology- acute,subacute and chronic toxicity. Animal tests (OECD and CPCSEA guidelines), Prodrugs, Formulation and Drug Delivery Systems. Clinical Trials-Ethical consideration, Regulatory requirements for Clinical Trials, Phases of Clinical Trials.

**UNIT IV**

8 h


**UNIT V**

8 h

Future Directions of Drug Development in the Pharma Industry- Biosimilars, Novel Drug delivery systems. Drug targeting- Target Identification, Methods used to identify potential drug targets, Target Validation, Drug Interaction with targets or receptors; In silico models in drug discovery and development, Molecular modeling in silico, Computer models to predict ADMET, The ‘omics’ era in drug development: Proteomics, Genomics, Metalobomics, Pharmacogenomics- The promise of personalized medicine.

**Text Books:**


**References:**

2. Ho et al., Biotechnology and Biopharmaceuticals Transferring Proteins and Genes, 2003

**Course Outcome:** On completion of this course, students would be able to understand basics of drug discovery and development which would enable them able to apply knowledge gained in respective fields of pharmaceutical industry.
Course Objectives: To teach principles, synthesis methods, characterization and applications of biological nanomaterials.

Pre-requisite: Bachelor’s level course in Life Sciences

UNIT I  
10 h
Introduction to Nanobiotechnology: Definition and concepts, biological, microbial and nano world. Nanomaterials: nanoparticles, nanowires, nanoclusters, nanotubes, nanocomposites, nanovesicles, nanospheres and nanocapsules. Biomolecules as nanomaterials: lipids as nanobridges, proteins as nanomolecules, polysaccharides and nucleic acids in nanotechnology.

UNIT II  
10 h

UNIT III  
8 h
Characterization of nanomaterials: Confirmation of synthesis and characterization by UV-Vis spectroscopy, X-ray diffraction (XRD), Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), Selected-area electron diffraction (SAED), Energy dispersive x-ray analysis (EDAX) AFM, Infrared (IR) and Thermo gravimetric analysis (TGA) analysis.

UNIT IV  
10 h

UNIT V  
7 h

Text Books:

References:

Course Outcome: Students will acquire knowledge on the basic concepts of biological nanomaterials and their utility in health, agriculture and environment.
Course Objectives: To become familiar with India’s IPR Policy; To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products; To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications. DNA testing. In a rapidly developing life science industry, there is an urgent need for people to combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Pre-requisite: Bachelor’s level course in Life Sciences/ Chemical Sciences

UNIT I BIOSAFETY

Biosafety and Biosecurity - Introduction and overview of biological safety in plants and animals. Environmental risk assessment and food and feed safety assessment including heavy metal contaminations; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; National & International Regulations: OECD, EPA, RCGM, GEAC, IBSC, FSSAI and BRAI.

UNIT II BIOETHICS


UNIT III BIO-BUSINESS

Scope of bio-entrepreneurship, Competitive dynamics of pharma and biotech industries, Strategy and operation of bisector firms, Business implications and communication of innovations and entrepreneurship in biosectors- lab to market activities, IPR and Challenges in bio-marketing.

UNIT IV BIO-MANAGEMENT

Basic contracts and agreements for joint ventures and development, Business plan preparation including strategy and legal requirements, Business feasibility study, financial management, collaborations and partnerships.

UNIT V TECHNOLOGY MANAGEMENT

Information technology in Biobusiness; Assessment, development and upgradation of technology, Technology transfer, Quality control. Regulatory Compliances and procedures [CDSCO, ISO, NBA GMP, GLP], Public private agencies for bio-entrepreneurship (MSME, BIRAC and TTB-DST).

Text books and References:

6. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/


**Course Outcome:** Students should be able to understand the rationale for IPR and patents and their regulation. Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents; gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations; understand ethical aspects related to biological, biomedical, health care and biotechnology research. They would also gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

2. Characterization of nanoparticles using UV-vis spectroscopy/X-ray diffraction (XRD), Transmission electron microscopy (TEM)/Scanning electron microscopy (SEM)/Selected-area electron diffraction (SAED)/Energy dispersive x-ray analysis (EDAX).

3. Production of nanocomposites.

4. Analysis of intracellularly synthesized mycogenic nanoparticles in the mycelia by Inductively coupled plasma-optical emission spectroscopy (ICP-OES).

5. Analysis of surface-coating molecules in the biologically synthesized nanoparticles using Infrared (IR) and Thermogravimetric analysis (TGA).


7. Cytotoxicity assessment of nanoparticles-Peripheral blood mononuclear (PBMC) culture.

8. Biogenic nanoparticles as catalysts for the degradation of pollutants.

**Suggested Reading:**


1. Qualitative analysis of plant based drugs
2. Isolation of drugs by HPTLC (flavonoids/alkaloids)
3. Quantitative analysis of a drug (aspirin/paracetamol) by spectrophotometer/HPLC
4. Quantitative assay of drug/metabolite by ELISA
5. *Insilico* docking analysis of drug analogs
6. *In vitro* bioactivity assay- antioxidant activity/antidiabetic activity
7. Different routes of drug administration in rodents(Demo)
8. Evaluation of anti-inflammatory/analgesic effect of a drug (Demo)
9. Processing of biological fluids/tissues for biochemical assays
10. Isolation and processing of biological tissues for histopathological analysis

**Suggested Reading:**

2. Laboratory Handbook on Biochemistry S. Shanmugam, T. Satish Kumar, Paneer Sevam, PHI Learning Pvt Ltd. New Delhi 2010