

St. Xavier's College (Autonomous),  
Mumbai



Syllabus of the courses offered by the  
Post Graduate Department of Biotechnology  
(2017 onwards)

**Contents**

**Syllabus for the following courses:**

**Theory Courses**

MS.BTS.7.01	Biomolecules
MS.BTS.7.02	Immunology
MS.BTS.7.03	Molecular Biology
MS.BTS.7.04	Membrane Studies & Cell cycle regulation

**Practical Courses**

MS.BTS.7.01PR	Basic Laboratory Skills
MS.BTS.7.02PR	Microbiological & mo. Bio techniques
MS.BTS.7.03PR	Biochemistry
MS.BTS.7.04PR	Computational tools in Biology

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.01**

**TITLE: BIOMOLECULES**

**Overall learning objectives:**

**60 Lectures**

- To understand the structure ,function and purification of proteins
- To understand the topology of DNA
- To understand the basic concepts in neurobiology

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**UNIT 1:**

**Protein structure and purification**

**15 lectures**

**Learning objectives:**

- To understand the architecture of proteins
- To know the techniques of separation and purification of proteins and understand the underlying principles.

**Topics:**

- 1.1 Primary structure of proteins and their determination – end group analysis; cleavage of disulphide bond; separation, characterization of polypeptide chain; specific peptide cleavage reactions
- 1.1 Secondary structure – Ramachandran plot, helical structure, beta structure
- 1.2 Tertiary structure- fibrous (Collagen) and globular (Myoglobin) structure, Protein stability, protein denaturation
- 1.3 Quaternary structure – (Haemoglobin) subunit interaction, symmetry, subunit composition determination
- 1.4 Protein purification: Principles and methods

**UNIT 2:**

**Protein folding**

**15**

**lectures.**

**Learning Objective:**

- To understand the protein folding mechanism
- To study the molecules assisting protein folding

**Topics:**



1. J. Berg, J. Tymoczko & L. Stryer, Biochemistry, 5<sup>th</sup> edition, W. H. Freeman & Company publisher, 2002
2. G. Zubay, Biochemistry, 4<sup>th</sup> Edition, Wm .C. Brown Publishers, 1999
3. David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003
4. Nelson and Cox, Lehninger's Principles of Biochemistry, fourth edition, Macmillan Worth Publisher, 2004
5. Donald Voet and Judith Voet. Biochemistry third edition, John Wiley and sons, Inc publisher, 2004
6. Thomas Devlin, Textbook of Biochemistry with clinical correlations, Fifth Edition, John Wiley and sons, Inc publisher, 2002
7. Campbell and Farrell, Biochemistry, fourth and fifth ed, Thomson Brooks/Cole, 2005
8. R Murray, D Granner, P Mayes, Harpers Illustrated biochemistry, 26th Edition, McGraw Hills
9. William Nyhan, Nadia A Sakati, Diagnostic Recognition of Genetic Disease, Library of Congress cataloguing in publication data.
10. Arthur M Lesk, Introduction to Protein science Architecture, Function and Genomics, 1998 Oxford publishers
11. **Additional ref**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.02**

**TITLE: IMMUNOLOGY**

**Overall learning objectives:**

**60 Lectures**

To understand the structure and function of molecules involved in innate and adaptive immunity.

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**UNIT 1**

**Immunoglobulins**

**15 lectures**

**Learning objectives:**

- To understand the source and production of blood cells involved in immunity.
- To understand the structure, diversity, synthesis, and secretion of Immunoglobulins

**Topics:**

- 1.1 Haematopoiesis
- 1.2 Immunoglobulin fine structure
- 1.3 Immunoglobulin super family
- 1.4 Multigene organization of Ig gene
- 1.5 Variable region gene rearrangement
- 1.6 Generation of antibody diversity
- 1.7 Class switching among constant regions.
- 1.8 Synthesis, assembly, and secretion of Immunoglobulins

**UNIT 2: MHC and Regulation of immune response**

**15 lectures**

**Learning objective**

- To understand the mechanism of antigen processing and presentation.

- To understand the mechanism of B cell and T cell activation and the signalling pathways involved therein.
- To understand the importance of T cell regulation

**Topics:**

- 2.1 Cellular distribution of MHC molecule
- 2.2 Antigen processing and presentation
- 2.3 Exogenous and endogenous antigen processing
- 2.4 Self - MHC restriction of T cells
- 2.5 Presentation of non-peptide antigens
- 2.6 Activation of B lymphocytes
- 2.7 Activation of T lymphocytes
- 2.8 T-cell regulation

**UNIT 3: Effector molecules in Immune Response 15 lectures**

**Learning objective**

- To understand the complement system as the major effector of humoral immune response
- To understand cytokine as the signalling molecule of the immune system, its regulation and effect on the outcome of diseases.

**Topics:**

- 3.1 Complement system: Functions of Complement, Components, Activation and Regulation.
- 3.2 Cytokines: Properties, Receptors, Antagonists, Diseases, Therapeutic use of cytokines

**Unit 4 Immune Effector Mechanisms 15 Lectures**

**Learning objective:**

- To understand immune effector mechanisms in inflammation and infections

**Topics:**

- 4.1 Phagocytosis
- 4.2 The inflammatory process
  - 4.2.1 Role of neutrophils and other mediators in inflammation
  - 4.2.2 Role of NF-kb and STATs in inflammation
  - 4.2.3 Localised, systemic, and chronic inflammation and role of anti-inflammatory agents
- 4.3 Pattern recognition receptors: TLRs, NLRs, microbicidal peptides
- 4.4 Autophagy
- 4.5 Immune response to bacterial and viral infections

**References:**

1. Goldsby, T J. Kindt, Osborne, Janis Kuby, Immunology, 5<sup>th</sup> Ed, Freeman, and company, 2003
2. Roitt, Brostoff, Male, Immunology, sixth Ed, Mosby, An imprint of Elsevier science Ltd, 2006
3. Abbas, Abul K & Lichtman, Cellular and molecular immunology. Fourth edition, W B Saunders company, 2000
4. Elgert, K. D. *Immunology: Understanding the immune system*. New York: Wiley-Liss. (1996).
5. Ian R Tizard, Immunology, An introduction, fourth edition. Thomson Publisher , 1994
6. Kenneth Murphy; Paul Travers; Mark Walport, Janeway's Immunobiology , 7<sup>th</sup> Edition , Garland Publishers , 2007

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.03**

**TITLE: MOLECULAR BIOLOGY**

**Overall learning objectives:**

**60 Lectures**

- To understand the content, constitution, and assembly of genomes in the eukaryotic system
- To elucidate the transfer of information from genes to RNA in detail

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**UNIT 1**

**Genomes: Anatomy**

**15 Lectures**

**Learning objective:**

- To understand the anatomy of eukaryotic genome and its significance

**Topics:**

1.1 Human nuclear genome

1.1.1 Genetic features of nuclear genome

1.1.2 Noncoding DNA

1.2 Human mitochondrial genome

1.3 Chloroplast Genome

1.4 Genomes of model organisms-

1.4.1 *Saccharomyces cerevisiae*

1.4.2 *Caenorhabditis elegans*,

1.4.3 *Arabidopsis thaliana*

1.4.4 *Drosophila melanogaster*

1.5 Human Genome Project: strategies and outcome

- Assembly of a contiguous DNA sequence using shotgun method, clone contig method and whole genome shotgun sequence method.

**UNIT 2                      Mapping of Genomes                      15 Lectures**

**Learning objective:**

- To understand the methodology of genome sequencing.

**Topics:**

- 2.1 Genetic Mapping: DNA markers for genetic mapping
- 2.2 Physical Mapping: Restriction Mapping, Fluorescent in situ hybridization (FISH), Sequence tagged site (STS) mapping.

**UNIT 3    Transcription in prokaryotes and eukaryotes                      15 Lectures**

**Learning objective:**

- To understand the interaction of proteins with DNA in the assembly of transcription machinery and its execution
- To understand the elongation, termination, and post transcriptional modification of the primary transcript

**Topics:**

- 3.1 DNA-Protein interactions during Transcription Initiation
- 3.2 Regulation of Transcription initiation
- 3.3 Synthesis of eukaryotic mRNAs by RNA polymerase II
- 3.4 Intron splicing
- 3.5 Synthesis and processing of Non-coding RNAs: Transcript elongation and termination by RNA polymerases I and III
- 3.6 Introns in eukaryotic pre-rRNA and pre-tRNA
- 3.7 Processing of Pre-RNA, Degradation of mRNAs

**UNIT 4: Translation and Post translational modifications                      15 Lectures**

**Learning objective:**

- To study the mechanism of translation and post translational modifications

**Topics:**

- 4.1 Basic mechanisms of RNA to Protein conversion
- 4.2 Post-translational Processing
- 4.3 Processing by proteolytic cleavage
- 4.4 Processing by chemical modification
- 4.5 Protein Degradation

**References:**

1. Benjamin Lewin , Gene VII, 2000, Oxford University Press Publishers
2. T A Brown, Genomes 3, third edition, 2007, Garland Science Publishing.
3. Simmons, Gardner , Principles of genetics ,8<sup>th</sup> ed, John Wiley and sons, Inc publishers, 2006
4. Donald Voet and Judith Voet. Biochemistry third edition, 2004, John Wiley and sons, Inc
5. T D. Watson and others, Molecular biology of the gene, 6<sup>th</sup> edition, 2004, Pearson education ltd.
6. G M Cooper, The Cell, a molecular approach, Library of Congress cataloguing in publication data.
7. Griffiths, A. and Miller J , An introduction to genetic analysis , 2000, W.H. Freeman ,
8. Lodish. H, Berk, A Molecular cell biology , 4<sup>th</sup> Ed, John, , 2000, Wiley and sons, Inc

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.04**

**TITLE: MEMBRANE STUDIES AND CELL CYCLE REGULATION**

**Overall learning objectives:**

**60 Lectures**

- To understand the architecture and function of membranes with aspects of cellular signalling
- To understand cell cycle and cell death process.

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**UNIT 1**

**Membrane Architecture**

**15 Lectures**

**Learning objective:**

- To understand the structure and assembly of membranes.
- To understand the types of lipoproteins

**Topics:**

1.1 Membrane Structure and dynamics

1.1.1 Composition and Architecture of membrane: lipids and proteins (integral and peripheral), Hydropathy index

1.1.2 Dynamics- lipid movements, flippase, FRAP, Lipid raft, Membrane fusion.

1.2 Solubilisation of the membrane by using different detergents.

1.3 Lipoproteins – structure, association with proteins and function

1.3.1 Types of Lipoproteins

**Unit II**

**Membrane Studies**

**15 Lectures**

**Learning Objectives:**

- To study the membrane functions and their utility in pharmaceuticals

**Topics:**

2.1 Membrane functions

2.1.1 Membrane transport: facilitated diffusion (Glut 1) and Primary and Secondary active transport (P, F, ABC, symporter, and antiporter)

2.1.2 Intracellular membrane transport: Transport of molecules between nucleus and cytosol, Endoplasmic reticulum

2.2 Liposome structure and their uses in drug targeting

**UNIT 3:**

**Biosignaling**

**15 Lectures**

**Learning objective**

- To elucidate the cellular signalling in control of gene activity and sensory pathways

**Topics:**

3.1 Cell signalling pathways that control gene activity-

3.1.1 TGF-Beta and activation of Smads

3.1.2 Regulation of TGF-Beta by negative feedback loops.

3.1.3 Cancer and loss of TGF-Beta signalling

3.2 Activation of gene transcription by seven-spanning cell surface receptors: Wnt and Hedgehog

3.3 Sensory transduction in vision, olfaction, and gustation

**UNIT 4:**

**Cell cycle and its regulation**

**15 Lectures**

**Learning objective:**

- To understand eukaryotic cell cycle and its regulation
- To understand cell death and its regulation

**Topics:**

4.1 Cell cycle phases, Control of mitosis by cyclins , MPF activity and cyclin dependant kinases

4.2 Checkpoints in cell cycle regulation

4.3 Apoptosis pathways and its regulation

4.4 *In Vitro* systems to study cell death.

**References:**

1. Mathews, Van Holde , Biochemistry, second ed. , The Benjamin/ Cummins publishing Company
2. Donald Voet and Judith Voet. Biochemistry third edition, 2004, John Wiley and sons, Inc.
3. T D. Watson and others, Molecular biology of the gene, 6<sup>th</sup> edition, 2004, Pearson education Ltd.
4. Benjamin Lewin , Gene VII, 2000, Oxford University Press Publishers
5. Karl Branden and John Tooze , introduction to Protein structure , 2<sup>nd</sup> ed, garland publishers, 1999.
6. Lodish. H, Berk, A Molecular cell biology , 4<sup>th</sup> John, 2000 Wiley and sons, Inc

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.01PR**

**TITLE: BASIC LABORATORY AND SCIENTIFIC COMMUNICATION SKILLS**

**Learning Objectives:**

1. To learn basic laboratory skills and good laboratory practices
2. To learn how to plan and execute experiments and analyse the data obtained.

**Topics:**

1. Introduction to good laboratory practices
2. Preparation of solutions and buffers
3. Calibration of instruments: pH meter, analytical balance, UV-spectrophotometer, colorimeter
4. Calibration of apparatus used for measuring: glass pipettes, auto pipettes and measuring cylinders.
5. Validation: Autoclave, Laminar air flow
6. Introduction to principles of Quality assurance and Quality control
7. Scientific communication:
8. Gathering scientific data from various sources.
  - a. Written communication : Guide to clear writing , forms, and styles of writing.
  - b. Oral communication variants
  - c. Concept of Plagiarism

**Recommended Books:**

1. Biochemical calculations (2<sup>nd</sup> Ed, 2004) Irwin H Segel, Wiley Publications
2. Principles and techniques of Biochemistry and molecular biology (7<sup>th</sup> Ed, 2010) Keith Wilson and John Walker, Cambridge university Press

3. Anthony Wilson , Handbook of Science Communication, IOP publishing Ltd. CRC press (1999)
4. Relevant SOPs from USP and IP

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.02PR**

**TITLE: MICROBIOLOGY AND MOLECULAR BIOLOGY TECHNIQUES**

**Learning Objectives:**

1. To learn the basic microbiology techniques and good microbiology laboratory practices.
2. To learn the basic techniques of extraction and quantification of genetic material from organisms and biological fluids
3. To learn how to plan and execute experiments and analyse the data obtained.

**Topics:**

1. Introduction to basic microbial techniques
  - a. Identification of micro-organisms
  - b. Sterility testing
2. Extraction of Genomic DNA Extraction from Bacteria
3. Extraction of Genomic DNA Extraction from Human samples
  - a. Cheek cells
  - b. Blood
4. Quantification of Biomolecules using UV (nucleic acids and proteins)

**References:**

1. Principles and techniques of Biochemistry and molecular biology (7<sup>th</sup> Ed, 2010) Keith Wilson and John Walker, Cambridge university Press
2. Biochemistry Laboratory (2<sup>nd</sup> Ed, 2012) Rodney Boyer, Pearsons Publication
3. Biotechnology explorations (2000), Shepler J and Cassin P, ASM Press

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.03PR**

**TITLE: BIOCHEMISTRY**

1. To learn the basic techniques of separation, quantification, purification, and characterisation of proteins.
2. To learn how to plan and execute experiments and analyse the data obtained.

**Topics: Protein separation and quantification**

1. Protein Estimation using the following methods:
  - a. Biuret assay
  - b. Bradford's assay
  - c. Folin-Lowry assay

2. Protein Separation by electrophoresis:
  - a. Polyacrylamide gel electrophoresis (native and SDS)
  - b. Horizontal gel electrophoresis (Slide and Slab)
3. Protein gel staining techniques:
  - a. Coomassie brilliant blue , silver staining , TCA and Ponceau staining
  - b. Activity staining : LDH
4. Protein Purification techniques:
  - a. Protein Precipitation
  - b. Ion exchange Chromatography
  - c. Gel filtration
  - d. Affinity Chromatography
  - e. Study of purified Immunoglobulins using SDS PAGE
5. Viscosity studies of proteins

**References:**

1. Principles and techniques of Biochemistry and molecular biology (7<sup>th</sup> Ed, 2010)  
Keith Wilson and John Walker, Cambridge university Press
2. Biochemistry Laboratory (2<sup>nd</sup> Ed, 2012) Rodney Boyer, Pearsons Publication

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER I**

**COURSE CODE: MS.BTS.7.04PR**

**TITLE: COMPUTATIONAL TOOLS IN BIOLOGY**

**Topics:**

- Introduction to computational tools in biology :
  - Retrieval of protein , nucleotide, and protein structural data for analysis
- Nucleotide sequence analysis
  - a. Study Human genome data
  - b. Human genome project and its implications
  - c. Exploration of human genome databases ,
  - d. Mitochondrial databases and its importance
  - e. Study of organism specific databases : Eg: *Saccharomyces* , *Caenorhabditis elegans* , *Arabidopsis* and *Drosophila*
  - f. Study of nucleotide sequence : Intron- exon finding , ORF finding.
- Protein sequence analysis
  - a. Primary protein sequence analysis
  - b. Secondary sequence analysis
  - c. Tertiary structure analysis

**References:**



**St. Xavier's College – Autonomous**

**Mumbai**

**Syllabus**

**For II<sup>nd</sup> Semester Courses in M. Sc in Biotechnology**

**(November 2017 onwards)**

**Contents**

**Syllabus for the following courses:**

**Theory Courses**

- MS.BTS.8.01 Metabolism and PTC in metabolic engineering
- MS.BTS.8.02 Clinical Immunology
- MS.BTS.8.03 Molecular and Cellular Biotechnology
- MS.BTS.8.04 Advanced Analytical Techniques

**Practical Courses**

- MS.BTS.8.01PR Biochemical Techniques and Assays
- MS.BTS.8.02PR Molecular Biology
- MS.BTS.8.03PR Immunology and Animal cell culture
- MS.BTS.8.04PR Analytical Techniques Data Interpretation

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.01**

**TITLE: MS. BTS.2.01 METABOLISM AND PTC IN METABOLIC ENGINEERING**

**Overall learning Objectives:**

**60 Lectures**

- To understand metabolic pathways and their interrelationships
- To study the nutritional diseases associated with abnormal metabolism.
- To study plant metabolism

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**Unit 1 Carbohydrate and Lipid metabolism**

**15 Lectures**

**Learning objective**

- To understand how energy is stored in carbohydrates and the diseases caused by excessive accumulation of glycogen.
- To study lipid metabolism and its clinical implications.

**Topics:**

1.1 Carbohydrate metabolism

1.2 HMP, Uronic acid pathway

1.3 Glycogenesis and Glycogenolysis

1.4 Glycogen storage diseases

1.5 Lipid metabolism: synthesis of essential fatty acids and its biological significance.

1.6 Lipoprotein Metabolism and role of Lipoproteins in diseases.

**Unit 2 Protein and Nucleic acid Metabolism**

**15 Lectures**

**Learning objectives:**

- To study the metabolic pathways of amino acids and nucleic acids and associated disorders

**Topics:**

- 2.1 Metabolism of amino acids
- 2.2 Biosynthesis of phenylalanine, tyrosine, threonine, and methionine
- 2.3 Metabolic breakdown of amino acids
- 2.4 Disorders of amino acid metabolism
- 2.5 Biosynthesis and degradation of purines and pyrimidines
- 2.6 Regulation of metabolism
- 2.7 Disorders of Nucleic acid metabolism

**Unit 3                      Plant metabolism                      15 Lectures**

**Learning objectives:**

To study the fundamentals of carbohydrate and nitrogen metabolism in plants

**Topics:**

- 3.1 C-3 cycle and C-4 cycles
- 3.2 CAM, glyoxylate pathway
- 3.3 Photosynthetic formation of hydrogen
- 3.4 Nitrogen fixation and role of nitrogenase.

**Unit 4      Applications of cell culture in metabolic engineering                      15 Lectures**

**Learning objective:**

To understand the application of plant cell culture in secondary metabolite production

**Topics:**

- 3.1 Cell suspension cultures (batch and continuous) and immobilised cell culture systems,
- 3.2 Scale-up procedures in bioreactors, types of bioreactors for plant cell cultures.
- 3.3 Secondary metabolism and *in vitro* culture systems for secondary metabolites (including hairy root culture techniques)
- 3.4 Manipulation in production profile by biotic and abiotic elicitation; biotransformation
- 3.5 Cryopreservation and conservation of germplasm

**References:**

1. J. Berg, J. Tymoczko & L. Stryer, Biochemistry, 5<sup>th</sup> edition, W. H. Freeman & Company publisher, 2002
2. Nelson and Cox, Lehninger's Principles of Biochemistry, fourth edition, Macmillan Worth Publisher, 2004
3. Donald Voet and Judith Voet. Biochemistry third edition, John Wiley and sons, Inc publisher, 2004
4. Thomas Devlin, Textbook of Biochemistry with clinical correlations, Fifth Edition, John Wiley and sons, Inc publisher, 2002
5. R Murray, D Granner, P Mayes, Harpers Illustrated biochemistry, 26th Edition, McGraw Hills
6. Karl-Hermann Neumann, Ashwani Kumar, Jafargholi Imani, 2009, Plant Cell and Tissue Culture - A Tool in Biotechnology, Basics and Application, Springer-Verlag Berlin Heidelberg
7. M K Razdan, 2005, Introduction to Plant Tissue Culture
8. Cseke L.J., Kirakosyan A., Kaufman P.B., Warber S.L., Duke J.A. and Briemann H.L. Natural Products from Plants, 2nd edition, Taylor & Francis group, 2006.

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.02**

**TITLE: CLINICAL IMMUNOLOGY**

**Overall learning objectives:**

**60 L**

- To understand the response of the human body towards allergens, grafts, tumors and infections.
- To understand the immune deficiencies and diseases

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**Unit 1 Hypersensitivity and Transplantation Immunology**

**15 Lectures**

**Learning objective:**

- To study the classification and mechanism of hypersensitivity
- To understand the types of transplantation and immune response towards it

**Topics:**

- 1.1 Hypersensitivity
  - 1.1.1 Gel and Coomb's Classification
  - 1.1.2 Type I, II, III, IV hypersensitivity
- 1.2 Transplantation immunology
  - 1.2.1 Basis of Graft rejection,
  - 1.2.2 Clinical manifestation of graft rejection
  - 1.2.3 Immune tolerance
  - 1.2.4 Immunosuppressive therapy
  - 1.2.5 Clinical transplantation

**Unit 2 Tumor immunology**

**15 Lectures**

**Learning objective:**

- To understand the immune response involved in tumour progression and antibody-based therapeutics.

**Topics:**

- 2.1 Oncogenes and cancer induction
- 2.2 Tumors of immune system
- 2.3 Tumor antigens
- 2.4 Tumor evasion of immune system
- 2.5 Cancer immunotherapy

**Unit 3 Immuno-deficiency and autoimmune diseases**

**15 lectures**

**Learning objective:**

- To understand the mechanism of natural and pathogen induced immunodeficiency.
- To understand Autoimmunity.

**Topics:**

3.1 Primary immunodeficiency

3.2 Secondary immunodeficiency

3.3 Autoimmunity: Organ specific, systemic, mechanism, treatment

#### **Unit 4 Experimental systems and advances in Immunology**

**15 Lectures**

##### **Learning objective:**

- To study the various experimental systems and techniques involved in understanding Immune biology.

##### **Topics:**

4.1 Animal models: Inbred strains, Knock out/Knock in, transgenic models, models for immune diseases.

4.2 *In vitro* systems

4.3 Ag-Ab interaction assays for understanding immune biology, diagnostics, and therapeutics.

4.4 Flow cytometry

4.5 Antibody engineering (inclusive of hybridoma technology, display libraries and examples)

##### **References:**

1. Goldsby, T J. Kindt, Osborne, Janis Kuby, Immunology, fifth Ed, Freeman, and company.
2. Roitt, Brostoff, Male, Immunology, sixth Ed, Mosby, An imprint of Elsevier science Ltd
3. Abbas, Abul K & Lichtman, Cellular and molecular immunology. Fourth edition, W B Saunders company
4. Ian R Tizard, Immunology, An introduction, fourth edition. Thomson Publisher
5. Wener Luttmann, K Bratke, M. Kupper, D Myrtek, Immunology the experimental series publisher
6. Gordan Reeve and Ian Todd, Immunology, fourth edition. Blackwell Publishing House
7. Elgert, K. D. (1996). *Immunology: Understanding the immune system*. New York: Wiley-Liss.
8. Henry Y. Wang , Tadayuki Imanaka(1995. Antibody Expression and Engineering, Vol 604, American Chemical Society
9. William R. Strohl and Lila M. Strohl (2012). Therapeutic antibody engineering, Woodhead Publishing Limited.

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.03**

**TITLE: MOLECULAR AND CELLULAR BIOTECHNOLOGY**

**Overall learning objectives:**

**60 L**

- To understand the regulation of genome activity
- To study the basics of recombinant DNA technology
- To understand basic concepts and techniques in animal cell biotechnology

**UNIT 1**

**Regulation of Genome Activity**

**15 Lectures**

**Learning objective:**

- To study the regulation of gene activity using specific examples

**Topics:**

1.1 Genome rearrangements

1.2 Gene silencing by modification of histones and DNA

1.3 Regulation of Genome Activity during Development:

1.3.1 Vulva development in *Caenorhabditis elegans*

1.3.2 Development in *Drosophila melanogaster*

1.4 Genome editing techniques: RNAi, Nucleases (Zn finger nucleases, Transcription associated nucleases, CRISPR- Cas9)

**UNIT 2:**

**DNA VECTORS**

**15 Lectures**

**Learning objectives:**

To understand the construction of specific vectors for protein studies and high-capacity genomic libraries

**Topics:**

## 2.1 Expression vectors

- 2.1.1 For maximizing protein synthesis
- 2.1.2 To facilitate protein purification
- 2.1.3 To promote protein solubilisation
- 2.1.4 To promote protein export
- 2.1.5 Vectors for making RNA probes.
- 2.1.6 BACs and PACs

## 2.2 Cloning in Yeast-

- 2.2.1 Plasmid vectors, expression of cloned genes, over expression of proteins
- 2.2.2 Yeast two hybrid system

## 2.3 Vectors in Animal cells-plasmid vectors, selectable markers

- 2.3.1 Viral vectors-Adeno, retro, lenti virus

### **Unit 3            Application of rDNA technology**

**15 Lectures**

#### **Learning objectives:**

To study the application of recombinant microbes and plants

#### **Topics:**

- 3.1 Plant engineering to overcome abiotic and biotic stress.
  - 3.1.1 Insect Resistance
  - 3.1.2 Virus Resistance
  - 3.1.3 Herbicide Resistance
  - 3.1.4 Salt and Drought Stress
- 3.2 Plant engineering for modification of nutrient content:
  - 3.2.1 Amino Acids, Lipids, Vitamins, Iron
- 3.3 Synthesis of commercial products - Restriction Endonucleases

## UNIT 4

## Animal Cell Culture

15 Lectures

### Learning Objective:

- To understand the concepts and techniques involved in culturing animal cells *in vitro*.
- To understand the applications of *invitro* culturing of cells

### Topics:

- 4.1 Biology of cultured cells
- 4.2 Primary Culture and development of cell lines – normal and tumor
- 4.3 Maintenance of cells in culture: subculture, contamination, and cryopreservation
- 4.4 Characterisation of cells in culture
- 4.5 Transformation, immortalisation, and Differentiation
- 4.6 3-D culture: organ culture, histiotypic culture and organotypic culture
- 4.7 Cytotoxicity

### References:

1. Benjamin Lewin , Gene VII, Oxford Publishers
2. T A Brown , Genome, Second edition, Bios Scientific publishers
3. Old and Primrose, Principles of Gene Manipulation. Blackwell Science publishers
4. Donald Voet and Judith Voet. Biochemistry third edition, 2004, John Wiley and sons, Inc
5. T D.Watson and others, Molecular biology of the gene , 6<sup>th</sup> edition , 2004 , Pearson education ltd.
6. G M Cooper, The Cell, a molecular approach, Library of Congress cataloguing in publication data.
7. Griffiths, A. and Miller J , An introduction to genetic analysis , Freeman
8. Lodish, Berk, A Molecular cell biology , John Wiley and sons, Inc
9. Sambrook J, Russell., Molecular cloning, Vol I, II , III, CSHL Press
10. T A Brown, Gene cloning and DNA analysis, Bios Scientific publishers
11. Bernard Glick , Jack Pasternak and Cheryl Patten, Molecular Biotechnology- principles and applications of Recombinant DNA, 4<sup>th</sup> ed, ASM Press, 2010
12. Culture of Animal Cells, R Ian Freshney, Wiley Publications, 5<sup>th</sup> / 6<sup>th</sup> Ed
13. Animal Cell Culture: Essential Methods , John M Davis, John Wiley & Sons
14. Relevant current research articles.

**COURSE: MS.BTS.8.04**

**ADVANCED ANALYTICAL TECHNIQUES**

**Overall learning objectives:**

**60 L**

- To understand the principles and applications of various analytical techniques used to study Biomolecules.
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**Topics:**

**Unit 1**

**Spectroscopy**

**15 Lectures**

**Learning Objectives:**

- To understand the conformation and structural details of Biomolecules using spectroscopic techniques

**Topics:**

2.5 Basic principles, instrumentation, and applications of the following:

1.1 Fluorescence spectroscopy

1.2 ORD

1.3 CD spectroscopy

1.4 NMR

1.5 ESR

**Unit 2**

**Advances in Microscopy and X-Ray Crystallography**

**15 Lectures**

**Learning objective:**

- To study the current methods and applications of advanced biological imaging systems
- To gain knowledge of techniques used to obtain the structural insights of proteins.

**Topics:**

**2.1 Advanced Microscopy**

2.1.1 Different versions of advanced microscopy

2.1.2 Electron microscopy

2.1.3 Confocal Microscopy

**2.2 X-Ray Crystallography**

2.2.1 Principles, instrumentation, and application of X ray crystallography.



4.1 2-D PAGE

4.2 Advances in Chromatography

4.3 Mass spectrometry

4.4 MALDI-TOF-MS/MS

4.5 Biochips (DNA, Protein and Biosensors)

**References:**

1. Donald Voet and Judith Voet. Biochemistry third edition, 2004, John Wiley and sons
2. R Cotterill , Biophysics, An Introduction , John Wiley and sons, Inc
3. Skoog, Holler, Nieman. , Principles of instrumental analysis , Thomson publishers
4. Daniel M, Basic Biophysics 2004 , Student Edition
5. Bartlett & Stirling , PCR protocols, 2<sup>nd</sup> ed ., Humana publishers
6. David Spector and Robert Goldman, Basic methods in microscopy. Cold spring harbour laboratory press, 2006
7. Douglas Chandler and Robert Robertson, Bioimaging – current concepts in light and electron microscopy, Jones, and Bartlett publishers, 2009.

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.01PR**

**TITLE: BIOCHEMICAL TECHNIQUES AND ASSAYS**

**Overall Learning Objectives:**

- To learn the basic techniques for understanding metabolism
- To plan, execute experiments and analyse the data obtained.

**Topics:**

1. Determination of acid value of lipids
2. Determination of phosphorus from serum
3. Estimation of cholesterol from the serum sample
4. Estimation of Urea from serum or urine
5. Estimation of Creatinine from serum or urine
6. Isolation of chloroplast by sucrose gradient centrifugation
7. Measurement of chlorophyll content
8. Measurement of proton uptake by DCPIP
9. Separation of photosynthetic pigments by chromatography
10. Vitamin B12 bioassay
11. Enzymatic assay (Invertase)

**References:**

1. Principles and techniques of Biochemistry and molecular biology (7<sup>th</sup> Ed, 2010) Keith Wilson and John Walker, Cambridge university Press
2. Textbook of Medical Laboratory Technology (2<sup>nd</sup> Ed, 2006), Praful Godkar, Bhalani Publishing House.
3. Biochemistry Laboratory (2<sup>nd</sup> Ed, 2012) Rodney Boyer, Pearsons Publication
- 4.

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.02PR**

**TITLE: MOLECULAR BIOLOGY**

**Learning Objectives:**

- To learn the basic techniques in recombinant DNA technology
- To plan, execute experiments and analyse the data obtained.

**Topics:**

1. Isolation of DNA from yeast
2. Isolation of RNA from yeast/ *E.coli*
3. Creation of genomic library
  - i. Isolation of genomic DNA
  - ii. Isolation of Plasmid DNA
  - iii. Restriction Digestion
  - iv. Ligation
  - v. Transformation
4. Expression of recombinant proteins
5. PCR amplification of 16srRNA
6. RFLP analysis
7. Preparation of glycerol stocks

**References:**

1. Molecular Cloning : Laboratory Manual Vol I, 2001 , Joseph Sambrook, David William Russel, CHL Press

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.03PR**

**TITLE: IMMUNOLOGY AND ANIMAL CELL CULTURE**

**Learning Objectives:**

- To learn the basic tools used in Immunology.
- To learn the basic techniques in animal cell culture
- To plan, execute experiments and analyse the data obtained.

**Topics:**

1. Isoagglutination titre study
2. Single Radial Immunodiffusion
3. Dot-ELISA
4. Antibody/ antigen capture ELISA
5. Western Blot Technique
6. General aseptic techniques and preparation for ACC
7. Media preparation for ACC
8. Primary culture using chick embryo.
9. Subculture of cell lines
10. Karyotyping and G- Banding using human blood cells.

**References:**

1. Goldsby, T J. Kindt, Osborne, Janis Kuby, Immunology, fifth Ed, Freeman, and company, 2003
2. Culture of Animal Cells, R Ian Freshney, Wiley Publications, 5<sup>th</sup> / 6<sup>th</sup> Ed

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: MS.BTS.8.04PR**

**TITLE: ANALYTICAL TECHNIQUES DATA INTERPRETATION**

**Learning Objectives:**

- To plan, execute experiments and analyse the data obtained.
- 

**Topics:**

1. Instrumentation and Data interpretation of the following techniques
  - a. HPLC

- b. Gas chromatography
- c. 2D electrophoresis
- d. Mass spectrometry
2. Study of metabolic pathway databases eg: KEGG
3. Primer designing
4. Primer validation and study of PCR condition
5. Study of properties of nucleotide sequence : nucleotide count , translation , reverse translation
6. Study of in silico restriction digestion
7. Study of vectors
8. Gene finding

**References:**

1. Principles and techniques of Biochemistry and molecular biology (7<sup>th</sup> Ed, 2010) Keith Wilson and John Walker, Cambridge university Press



**St. Xavier's College – Autonomous**

**Mumbai**

**Syllabus**

**For 3<sup>rd</sup> Semester Courses in M.Sc in Biotechnology**

**(June 2017 onwards)**

**Contents**

**Syllabus for the following courses:**

**Theory Courses**

MS.BTS.9.01	Biostatistics And Bioinformatics
MS.BTS.9.02	Applications of Biotechnology
MS.BTS.9.03	Bioprocess Technology
MS.BTS.9.04	Environmental Biotechnology

**Practical Courses**

MS.BTS.9.01PR	Bioinformatics
MS.BTS.9.02PR	Animal Cell Culture
MS.BTS.9.03PR	Bioprocess Technology
MS.BTS.9.04PR	Research Methodology

**COURSE CODE: MS. BTS. 3.01**

**BIOSTATISTICS AND BIOINFORMATICS**

**Overall Learning Objective:**

**Total Lectures: 60**

- To understand core applied biostatistical concepts and methods.
- To deepen the knowledge in basic computational science for the management and analysis of biological data

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**UNIT 1**

**Introduction to Biostatistics**

**15 Lectures**

**Learning objective:**

- To understand the basic concepts of biostatistics

**Topics:**

1. Measure of central tendency ( mean, median and mode)
2. Measure of dispersion (Standard deviation , variance, and coefficient of variance)
3. Z- test (one mean , two means and paired)
4. t- Test (one mean, two means , paired and cochran's )
5.  $\chi^2$  test ( test of homogeneity, Independence Goodness of fit)
6. P- value for all tests ( Reading tables)
7. Regression
8. ANOVA

**UNIT 2**

**Applied Biostatistics**

**15 Lectures**

**Learning Objective:**

- To understand the application of biostatistics in biological study

**Topics:**

1. Statistical Experimentation : Introduction , test , control
2. Experimental design and terms
3. Theory of probability , density function ( Estimation etc)
4. The standard Normal distribution
5. Hypothesis Testing : step, errors
6. Nonparametric tests: Sign , Wilcoxon, and Mann- Whitney test

### UNIT 3

### Databases and Sequence Alignment

15 Lectures

#### Learning Objectives:

- To understand and access various types of data relating to molecular biology available on internet portal.
- To understand to the concept of sequence alignment of biological macromolecules

#### Topics:

1. **Introduction to Bioinformatics:** Goal , Scope, application (outline), new themes
2. **Study of biological databases**
  - a. Concept of databases
  - b. Biological data and databases, classification Examples of databases (sequence, structure, classification, genome, microarray, secondary databases etc )
  - c. Submission of sequences, biological data retrieval and study of data formats
  - d. Pitfalls of biological databases and annotations of biological data.
3. **Sequence alignment :**
  - a. Pairwise sequence alignment : sequence homology, similarity and identity , methods , scoring matrices, BLAST: types , method , parameters.
  - b. Multiple sequence alignment: scoring function goal and application , principle and methods, tools used.
  - c. Editing MSA: Jalview , Sequence logo
4. **Phylogenetic analysis and importance :**
  - a. Phylogenetics basics: Molecular Evolution and Molecular Phylogenetics, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation
  - b. Phylogenetic Tree Construction Methods and Programs: distance based, and character-based methods.

### UNIT 4 Protein Structure Visualization, Prediction, Genes and Genome Analysis

15 Lectures

#### Learning Objective:

- To analyse the protein sequences, retrieve and visualise protein structures.
- To analyse gene sequences and its expression at the genome and proteome level

#### Topics:

1. Study of proteins
  - a. Protein structure prediction: secondary structure and tertiary structure (Homology modelling)
  - b. Protein structure comparison , visualization, and significance
  - c. Bioinformatics basis of protein structural classification: CATH
  - d. Protein families, conserved domains , motifs
2. DNA/ gene sequence analysis:
  - a. Gene prediction : Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes, and eukaryotes
  - b. DNA motifs and its significance

3. Genomics and proteomics
  - a. Genome mapping, assembly, and comparison
  - b. Functional genomics: Microarrays and SAGE
  - c. Next-generation sequencing (NGS)
  - d. Proteomics: Technology of Protein Expression Analysis

**Reference Books:**

**Biostatistics:**

1. Wayne W Daniel (1999), Biostatistics: a foundation for analysis in health sciences, John Wiley, and sons
2. N Gurumani (2004), Introduction to Biostatistics, MJP Publishers.

**Bioinformatics:**

1. David Mount (2004) Bioinformatics: Sequence and Genome Analysis. 2<sup>nd</sup> edition, Cold Spring Harbor Laboratory Press, New York.
2. Jonathan Pevsner (2009) Bioinformatics and Functional Genomics. 2<sup>nd</sup> edition, John Wiley and Sons, New Jersey.
3. Teresa K. Attwood and D. J. Parry Smith (1999) Introduction to Bioinformatics. 1<sup>st</sup> edition , Pearson Education Limited , England
4. Andreas D. Baxevanis and B. F. Francis Ouellette (2001) Bioinformatics A Practical Guide to the Analysis of Genes and Proteins. 2<sup>nd</sup> edition, A John Wiley & Sons, Inc., Publication
5. Arthur M. Lesk (2005) Introduction to Bioinformatics , 2<sup>nd</sup> edition Oxford University Press
6. Jean-Michel Claverie and Cedric Notre's dame Bioinformatics for Dummies, 2<sup>nd</sup> edition, Wiley Publishing, Inc.
7. Jinn Xiong( 2006), Essential Bioinformatics, 1<sup>st</sup> edition, Cambridge university press ,

**COURSE CODE: MS. BTS. 9.02 Application of Biotechnology**

**Overall learning objective:**

**Total Lectures: 60**

- To understand basic concepts of human embryology
  - To understand the potential of animal cells, organ engineering and genetic engineering in Therapeutics and Industrial Biotechnology
- 

**UNIT 1 Human Embryogenesis and *In Vitro* Fertilization**

**15 Lectures**

**Learning objectives:**

- To understand the biology and technology of human embryo generation

**Topics:**

1. Embryonic development stages [fertilisation, post fertilisation, Implantation]
2. Establishment of germ layers and their fate
3. Immunology of pregnancy
4. IVF Technology

**UNIT 2 Stem cells and tissue engineering**

**15 Lectures.**

**Learning Objective:**

- To understand the potential of stem cell therapeutics
- To understand the concepts in generation of human tissues *in vitro*

**Topics:**

1. Types of stem cells: ES, Adult, iPSCs, Cancer stem cells
2. Characterisation of stem cells
3. Applications of stem cells in therapeutics
4. Ethical issues and regulations in stem cell research
5. Fundamentals of tissue engineering: Growth Factors, morphogens, Extracellular Matrix, Cell adhesion and migration, Inflammatory and Immune responses to tissue engineered devices.
6. Biomaterials : Polymeric scaffolds, Calcium Phosphate Ceramics, Bio mimetic materials
7. Applications of tissue engineering

### UNIT 3

### Biopharmaceuticals

15 Lectures

#### Learning objective:

- To understand the method of production and uses of modern-day therapeutic molecules.

#### Topics:

1. Scale up in cell culture ( types of bioreactors for suspension and monolayer cultures and process control)
2. Therapeutic peptides/ Biosimilars- production and dynamics
  - a. Production methodology
  - b. Pharmacokinetics and Pharmacodynamics
    - i. Insulin
    - ii. Tissue plasminogen activator
    - iii. Interferon – alpha
    - iv. Erythropoietin
    - v. Vaccines
    - vi. Monoclonal antibodies

### UNIT 4: Molecular Farming and Protein Engineering

#### Learning Objectives:

- To understand the application of genetic engineering techniques in therapeutics and industrial biotechnology

#### Topics:

- Chloroplast engineering
- Edible vaccine
- Directed mutagenesis – oligonucleotide directed, and PCR amplified.
- Protein engineering – increasing enzymatic activity, stability, and specificity; modifying metal cofactor requirements.

#### Reference Books:

1. Kaushik Deb and Satish Totey. (2009) Stem Cells Basics and Applications. Tata McGraw Hill.
2. Gary Stein and Maria B et al. (2011) Human Stem Cell Technology and Biology. Wiley Blackwell.
3. R. Ian Freshney, Glyn N. Stacey, Jonathan M. Auerbach. (2007) Culture of Human Stem Cells. John Wiley & Sons
4. Robert Lanza, Robert Langer, Joseph P. Vacanti. (2011) Principles of Tissue Engineering. Academic Press.
5. Inderbir Singh & GP Pal. (2007) Human Embryology. MacMillan Publishers.

6. Thomas W. Sadler. (2009) Langman's Medical Embryology. Lippincott Williams & Wilkins.
7. Scott F Gilbert.(2000) Developmental Biology, 6th edition. Sinauer Associates.
8. Gordana Vunjak-Novakovic, R. Ian Freshney. (2006) Culture of Cells for Tissue Engineering. John Wiley & Sons.
9. Daan J. A. Crommelin, Robert D. Sindelar. (2002) Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists. Taylor & Francis.
10. Bernard R. Glick, Jack J. Pasternak, Cheryl L.Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.

### **COURSE CODE: MS. BTS. 9.03 BIOPROCESS TECHNOLOGY**

**Overall Learning Objective:**

**Total Lectures: 60**

- To understand the microbial growth , fermentation, and product formation from the viewpoint of industrial purpose

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#### **UNIT 1**

#### **Principles of Bioprocess Technology**

**15 Lectures**

##### **Learning Objectives:**

- To understand basics of bioreactor kinetics and mathematical equations regarding bioreactors.
- To understand the idea of scale-up and aeration of bioreactors in detail.

##### **Topics:**

- Industrial substrates and stoichiometry
- Kinetics of microbial growth, substrate utilization and product formation: Batch , Fed-Batch and continuous processes
- Scale up concepts with respect to fermenter design and product formation.
- Solid state fermentation
- Processes using recombinant organisms: hosts, vectors, genetic instability.

#### **UNIT 2**

#### **Process dynamics**

**15 Lectures**

##### **Learning Objective:**

- To study the concept of mass and heat transfer

##### **Topics:**

- Gas exchange and mass transfer: O<sub>2</sub> transfer, critical oxygen concentration, determining the oxygen uptake rate.
- Heat transfer
- Sterilization – processes, thermal death curve, *in situ* sterilization



**COURSE CODE: MS. BTS. 9.04**

**ENVIRONMENTAL BIOTECHNOLOGY**

**Overall Learning Objective**

**Total Lectures: 60**

- To comprehend the concepts of pollution, its remediation through the biotechnological intervention
- To understand the concept of Biosafety , bioethics, and Quality assurance in the context of modern biotechnology

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**Unit 1: Environmental pollution and management**

**15 lectures**

**Learning Objectives:**

- To understand the aspects of environmental pollution
- To study role of biological entities in combating the environmental pollution

**Topics:**

1. Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Bioremediation, Biotransformation and Biodegradation- (specific case study)
2. Sources of heavy metal pollution; Microbial interactions, Microbial metal resistance; Microbial transformation; Accumulation and concentration of metals; Biosorption - biotechnology and heavy metal pollution.
3. Solid waste management of municipal , biomedical waste and E waste management
4. Xenobiotics; Persistence and biomagnification of xenobiotic molecules; Microbial interactions with xenobiotics.
5. Environmental impacts on agriculture: Biodegradation of agricultural chemicals; GM crops and their impact on environment; Phosphate solubilization; Biofertilizers; Biological control of insect pests; Role of biopesticides/ insecticides; Biocontrol of plant pathogens; Integrated pest management-practical implementation.

**Unit 2: Marine Pollution and Biodeterioration**

**15 lectures**

**Learning Objectives:**

- To understand the concepts of marine ecosystem and threats
- To sensitize the learner to the pollution aspects on marine ecosystem and the possible remedial measures

**Topics:**

1. Types of marine environment - Physical, Chemical and Biological aspects and their interaction with marine life; Air – Sea interaction. Threats to the Marine Environment: Marine pollution-major pollutants and biological indicators (Marine microbes, algae, and crustaceans) and accumulators:

2. Oil pollution: Sources, composition, and its fate in marine habitats. Treatment options available
3. Thermal and radioactive pollution: sources, effects, and remedial measures.
4. Solid dumping, mining, and dredging operations: their effects on marine ecosystem.
5. Biofouling and biodeterioration: Agents and protection methods.
6. Effect of marine pollution on environment and human health and Role of biotechnology in marine pollution control.

### **Unit 3: Environmental Monitoring and Management**

**15 lectures**

#### **Learning Objectives:**

- To create awareness about the organisations and process involved in environmental monitoring.
- To understand the national policies concerned with environmental management.
- To understand the role of biotechnology in the environmental management

#### **Topics:**

1. National Policy on Environment: National Committee on Environment and Planning (NCEP); Tiwari committee; Establishment of MoEF; National Forest Policy; National Water Policy and National Energy Policy; CPCB and SPCBs.
2. Environmental management : problems and need, Environmental management Plan.
3. Environmental impact assessment and ISO 14000
4. Biotechnology for management of resources: Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production, Biogas, and biofuel production Development of environmentally friendly processes such as integrated waste management,
5. White biotechnology - bioplastics; Concept of environmental sustainability

### **Unit 4 Safety, Ethics and QA aspects in Biotechnology**

**15 lectures**

#### **Learning Objectives:**

- To understand the concept of Biosafety ,bioethics and Quality assurance in the context of modern biotechnology
  - To understand the regulatory mechanisms for Biosafety and Genetic modifications in India and at international level.
  - To discuss the social and ethical issues related to plant and animal biotechnology.
- 

#### **Topics:**

1. Biosafety- history, Need for containment and levels ( microorganisms , plants, and animals – both GMOs and LMOs), primary containment of biohazards, BSCs , Clean Room technology

2. Regulatory guidelines: both national and International for food and food ingredients produced using GMOs, GM crops and livestock.
  - a. Cartagena Protocol
  - b. Role of IBSC, RCGM, GEAC and others
  - c. Safety and Environment Impact concerns with respect to GMOs, LMOs, GM foods, Crops and Livestock.
  - d. Risk assessment , management and communication including GMP, GLP and HACCP
  - e. Generally Recognised as Safe (GRAS)
3. Bioethical conflicts in Biotechnology
  - a. ELSI of HGP
  - b. Ethical concerns in GM utilized for consumption, agricultural benefits, or human therapy.
4. Quality assurance and control: concept
5. Documentation – SOPs and Validation overview

### Reference Books:

#### Environmental Biotechnology:

1. Indu Shekhar Thakur (2006) Environmental Biotechnology: Basic Concepts and Applications, I. K. International Pvt Ltd, 2006
2. Gareth M. Evans and Judith C. Furlong (2003) Environmental Biotechnology Theory and Application, John Wiley & Sons Inc.
3. Alan H. Scragg (2006) Environmental Biotechnology , 1<sup>st</sup> edition , Oxford University Press
4. S.K. Agarwal (2007) Environmental Biotechnology , APH Publishing Co-operation , New Delhi
5. Alexander N. Glazer and Hiroshi Nikaido (2010) Microbial Biotechnology, 2<sup>nd</sup> edition, Cambridge University press.
6. A.G. Murugesan and C. Rajakumari (2006) Environmental Science and Biotechnology Theory and techniques MJP Publishers , Chennai
7. Gwendolyn Holmes Bruce *et al*, (2000), Handbook of Environmental management and technology, Wiley Intersciences Publishers

#### Safety, Ethics and QA aspects in Biotechnology:

1. Bernard R. Glick, Jack J. Pasternak, Cheryl L.Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
2. Biosafety in Microbiology and biomedical laboratories, 5<sup>th</sup> Ed. (2009): CDC, NIH publication. HHS publication (21-1112)
3. Traavik. T and Lim Li Ching, (2007): Biosafety first. Tapir Academic Press

4. N. Alexandrova, K. Georgieva & A. Atanassov (2005) Biosafety Regulations of GMOS: National and International Aspects and Regional Cooperation, *Biotechnology & Biotechnological Equipment*, 19:sup3, 153-172.
5. Secretariat of the Convention on Biological Diversity (2000). Cartagena Protocol on Biosafety to the Convention on Biological Diversity: text and annexes. Montreal.
6. <http://dbtbiosafety.nic.in>
7. <http://igmoris.nic.in>
8. <http://www.dbtindia.nic.in/regulations/>
9. Brauer D, 1995, *Biotechnology* 2nd Edition, Vol 12, Legal, Social and Ethical dimensions. VCH publications.
10. Humberto Vega-Mercado, Michael Dekleva, Rizwan Sharnez, and Luis Baez, May 2003, HACCP: A Process Validation Tool for Ensuring Quality of Biotech and Pharmaceutical Products, *Bioprocess technology*

## PRACTICALS

### Overall Learning Objectives:

- To learn the basics of *in - silico* analysis of biological data
- To understand experimental design for *in vitro* cytotoxicity assays.
- To learn the basic techniques in fermentation.
- To understand the basis of research methodology
- To plan and execute experiments and analyse the data obtained.

### COURSE CODE: MS. BTS. 9.01PR

### BIOINFORMATICS

1. Study of databases
2. Sequence alignment :
  - a. Nucleotide BLAST
  - b. Protein BLAST
  - c. Study of orthologous and paralogous sequences using BLAST.
3. Sequence alignment and applications :
  - a. Multiple sequence alignment
  - b. Phylogenetic analysis
  - c. Studying consensus sequences
  - d. Generation of sequence Logo using multiple aligned sequences.
4. Analysis of nucleotide and protein sequences
  - a. Gene finding
  - b. Motif finding
  - c. Conserved domain identification
5. Classification of proteins using CATH and SCOPE.
6. Study of proteins:
  - a. Homology modelling
  - b. Visualization of proteins using various visualization tools.

### COURSE CODE: MS. BTS. 9.02PR ANIMAL CELL CULTURE

- Cytotoxicity testing using MTT and SRB.

### COURSE CODE: MS. BTS.9.03PR

### BIOPROCESS TECHNOLOGY

- Process development (upstream and downstream) eg. Alcohol production from the yeast *Saccharomyces cerevisiae*

### COURSE CODE: MS. BTS.9.04PR Research Methodology

1. Research approaches, Research Process and Criteria for Good Research
2. Research problem: definition , techniques involved , illustration.
3. Research design : meaning , Important Concepts and basic Principles of Experimental Designs
4. Research ethics
5. Internal Project

### References:

1. David Mount (2004) Bioinformatics: Sequence and Genome Analysis. 2<sup>nd</sup> edition, Cold Spring Harbor Laboratory Press, New York.
2. Culture of Animal Cells, R Ian Freshney, Wiley Publications, 5<sup>th</sup> / 6<sup>th</sup> Ed
3. Methods in Biotechnology (1997), Hansmauder Schmauder, Taylor and Francis Publications
4. C.R. Kothari, Research methodology: methods and techniques, 2<sup>nd</sup> edition, New Age International Publishers, 2004
5. James Morris, A students guide to writing in the life sciences, The President and Fellows of Harvard University, 2007



**St. Xavier's College – Autonomous**

**Mumbai**

**Syllabus**

**For 4<sup>th</sup> Semester Courses in M. Sc in Biotechnology**

**(October 2017 onwards)**

**Contents**

**Syllabus for the following courses:**

**THEORY COURSES**

MS.BTS.10.01 Drug designing and Nanotechnology

MS.BTS.10.02 Entrepreneurship and IPR

**PRACTICAL COURSES**

MS.BTS.10.01PR Intellectual Property Rights

MS.BTS.10.02PR Entrepreneurship

MS.BTS.10 PR Research project

**COURSE: MS. BTS. 10.01 DRUG DESIGNING AND NANOTECHNOLOGY**

**Overall Learning Objective: 60 Lectures**

- To gain an exposure to recent techniques in biopharmaceutical drug discovery
- To study the concept of nanotechnology, synthesis of nanoparticles and its applications

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**Unit 1 Drug Development 15 Lectures**

**Learning Objective:**

- To understand the quantitative structure – activity relationships of drug molecules
- To know the steps of drug discovery process

**Topics:**

1. Steps involved in drug discovery , Production and characterisation, Preclinical studies, and Validation studies.
2. Computer aided drug designing and docking.
  - a. General Principles of CADD
  - b. Types of drug designing
    - Ligand based molecular interactions.
    - Structure based Drug designing.
    - Examples of Ligand and structure-based drug designing
  - c. Applications and importance of CADD

**Unit 2 Clinical Research 15 Lectures**

**Learning objective:**

- To understand the relevance of clinical research in drug discovery process

**Topics:**

1. Introduction
2. Good clinical practice guidelines
3. Ethical aspects of clinical research
4. Clinical research methodologies and management
5. Regulatory requirements
6. Data management

**Unit 3 Regulatory Affairs and Pharmacovigilance 15 Lectures**

**Learning Objective:**

- To understand the role of monitoring of drugs before and after release by regulatory authorities

**Topics:**

1. Introduction to Adverse Events and Classifications
2. Scope of Drug Safety Problems
3. Introduction to Pharmacovigilance
  - History and development of pharmacovigilance
  - Importance of safety monitoring / Why pharmacovigilance
4. National and international scenario
  - Pharmacovigilance in India
  - Pharmacovigilance global perspective
  - WHO international drug monitoring programme
5. Pharmacovigilance methods
  - Passive surveillance – Spontaneous reports and case series
  - Stimulated reporting
  - Active surveillance – Sentinel sites, drug event monitoring and registries
  - Comparative observational studies – Cross sectional study, case control study and cohort study
6. Adverse drug reaction reporting
  - Spontaneous reporting system
  - Reporting to regulatory authorities
7. Drug Safety and FDA
8. ICH and FDA
9. Investigational New Drug Applications
10. Documents and Communication (Review period and approval period)

**Unit 4**

**Nanotechnology in medicine**

**15 Lectures**

**Learning objective:**

- To study the concept of nanotechnology, synthesis of nanoparticles and its applications
- To understand the applications of emerging nanotechnology in treating diseases

**Topics:**

1. Introduction to nanotechnology:
  - a. Introduction to nanotechnology and bio-nanotechnology
  - b. Important nanoparticles / materials, bio nanorobots/molecular motors nano motors and their uses (in brief)
2. Synthesis of nanoparticles:
  - a. Common Strategies for synthesis of nanomaterials with examples, (Biological methods for nanoparticle synthesis)
  - b. Characterization methods ( Brief outline)

3. Applications of nanotechnology:

- Medical nanotechnology
- Nano pharmaceuticals : Nanobiotechnology for drug discovery and drug delivery
- Nano-diagnostics : Nano particles for the detection and treatment of cancer, Nano arrays for molecular diagnostics , Nanoparticles for Molecular Diagnostics, nano barcode
- Role of nanotechnology in biological therapy , nano devices in medicine and surgery

**References:**

1. Daan J. A. Crommelin, Robert D. Sindelar. (2002) Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists. Taylor & Francis.
2. Thomas M. Jacobsen, Albert I. Wertheimer. (2010) Modern Pharmaceutical Industry: A Primer. Jones & Bartlett Publishers.
3. Oliver Kayser, Rainer H. Müller. (2006) Pharmaceutical Biotechnology. John Wiley & Sons.
4. Gary Walsh. (2006) Biopharmaceuticals: Biochemistry and Biotechnology. John Wiley & Sons.
5. Tommy Liljefors, Povl Krogsgaard-Larsen, Ulf Madsen. (2010) Textbook of Drug Design and Discovery. 4<sup>th</sup> Edition. CRC Press
6. Mansoor M. Amiji (Editor). (2006) Nanotechnology for Cancer Therapy. CRC Press.
7. Gabor , Hornyak, Joydeep Dutta , Harry F. Tibbas ,(2009) Fundamentals of Nanotechnology , CRC Press
8. Kewal K. Jain (2008) The handbook of nanomedicine. Humana Press
9. Scott E. McNeil ( 2009) , Nanoparticle therapeutics: a personal perspective, Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology , Vol 1 Issue 3

## **COURSE: MS. BTS. 10.02 ENTREPRENEURSHIP AND IPR**

**Overall learning objective:**

**60 Lectures**

- To Understand the commercial potential of research and business in Biotechnology
  - To understand the concepts of Intellectual Property Rights and its applications in Biotechnology
- 

### **Unit 1 Management principle and entrepreneurship**

**15 Lectures**

**Objective:**

- To provide students from a non-management orientation with a brief idea on the various functions in an organization, the role of various departments and how they function together in the creation of a successful and profitable company.
- To make students aware of entrepreneurship and motivate them to identify opportunities and dispel any fears they may have even in considering the same through Case Studies and talks by Entrepreneurs.

#### **Unit 1: Management principles**

##### **1. Marketing Management :**

- Understanding the role of marketing in Organizations
- Marketing Research and its importance
- Understanding the Microenvironment (Strengths and Weaknesses vis-à-vis your company and its competition) and the Macro Environment (Opportunities and Threats – PEST Analysis)
- Exit strategy.
- Brief Introduction to Demand Forecasting
- Market Segmentation and Target Markets; 5P's (Product, Price, Place, Promotion, People)

##### **2. Finance Management :**

- Understanding the role of finance in Organizations
- Financial Statements ;Taxes
- Interest Rates
- Break-even analysis

##### **3. Human Resource Management**

- Understanding the role of a HR Manager in Organizations
- Interviews
- Team building and organizational management.

##### **4. Entrepreneurship**

- Concept, meaning of entrepreneurship.
- Functions , types of entrepreneurships
- Stages of entrepreneurial process.

- Contribution of notable entrepreneurs in the field of biotechnology and applied biology. ( Case studies)

**Unit 2**

**Business of Biotechnology**

**15 Lectures**

**Learning objective:**

- To understand the commercial applications and the current market status of biotechnology and related areas like pharmaceutical and diagnostics.

**Topics:**

1. Project areas in biotechnology and applied biology.
2. Business concept:
  - Idea selection, brainstorming, project planning, conceptualization, and feasibility report
  - Idea generation and Product planning , process design
  - Project cost estimate, project profits
3. Biotechnology companies , their care and nurturing
4. Management in biotechnology
5. Growth of biotechnology industry in India
  - Rules & Regulations for set-up of Biotech companies
  - Government schemes and benefits for SME
  - Strategic Management & International market (Examples of companies and strategies adopted for their market.)

**UNIT 3**

**Basic Concepts of Patenting**

**15 Lectures**

**Learning objective:**

- To understand the rationale for patenting in biotechnology and its commercial applications

**Topics:**

1. Biotechnology and the law: objective, evolution, basic structure of gene techniques, applications, commercial potential of biotech inventions, rational for IPR protection
2. Patenting biotech inventions: objectives, concepts of novelty and concepts of inventive step, microorganisms, and moral issues in patenting biotech inventions
3. Plant varieties protection: objectives, justification, criteria for protection, international position, plant varieties protection in India, plant varieties protection under TRIPs
4. Patenting issues related to Biosimilars.

**UNIT 4 Geographical Indications and Traditional Knowledge: Concepts and Case Studies**

**15 Lectures**

**Learning Objective:**

- To understand the concepts of geographical indications, traditional knowledge, and their utility in biotechnology

**Topics:**

1. Protection of geographical indications : objectives, justification, international position, multilateral treaties, national level, Indian position
2. Protection of traditional knowledge : objective, concept of traditional knowledge, holders, issue concerning, bioprospecting and bio-piracy, alternative ways, protectability, need for a sui generis regime, traditional knowledge on the international arena, traditional knowledge at WTO, traditional knowledge at the national level, traditional knowledge digital library.
3. Case study related to basmati rice, erythropoietin, t-PA, glivec.
4. Permissible and non-permissible biotech patenting in India

**Reference books:**

1. Dynamics of Entrepreneurial Development & Management, Vasant Desai ,Himalaya Publishing House
2. “Entrepreneurship Development – small Business Enterprises”, Poornima M Charanthmath Pearson Education – 2005
3. Entrepreneurship Development” S S Khanka S Chand
4. Basic Biotechnology, Colin Ratledge and Bjorn Kristiansen, Cambridge University Press- 2<sup>nd</sup> Ed,2001
5. Prabudha Ganguly, (2001) Intellectual Property rights- unleashing the knowledge economy, Tata McGraw Hill Publishing Company Ltd.
6. Alexandra George (2006) Globalisation and Intellectual Property, Ashgate publishing company
7. Maarten Bode, (2008) Taking traditional knowledge to the market, Orient Longman Publishers
8. Sudeep Chaudhuri (2005), the WTO and India's Pharmaceutical industry, Oxford University Press.
9. Vandana Shiva (2002), Protect or Plunder? Understanding Intellectual Property Rights, Zed Books.
10. David Pressman (2016) Patent It Yourself 18<sup>th</sup> edition, Nolo Publishers

**PRACTICAL**

**Overall Learning Objective:**

- To train the students in different aspects of scientific research and entrepreneurship

**MS.BTS.10.01PR:** IPR ; Searching patents and analysing patents

**MS.BTS.10.02PR:** Entrepreneurship

**MS.BTS.10 PR:** Project for 4-5 months with Dissertation -