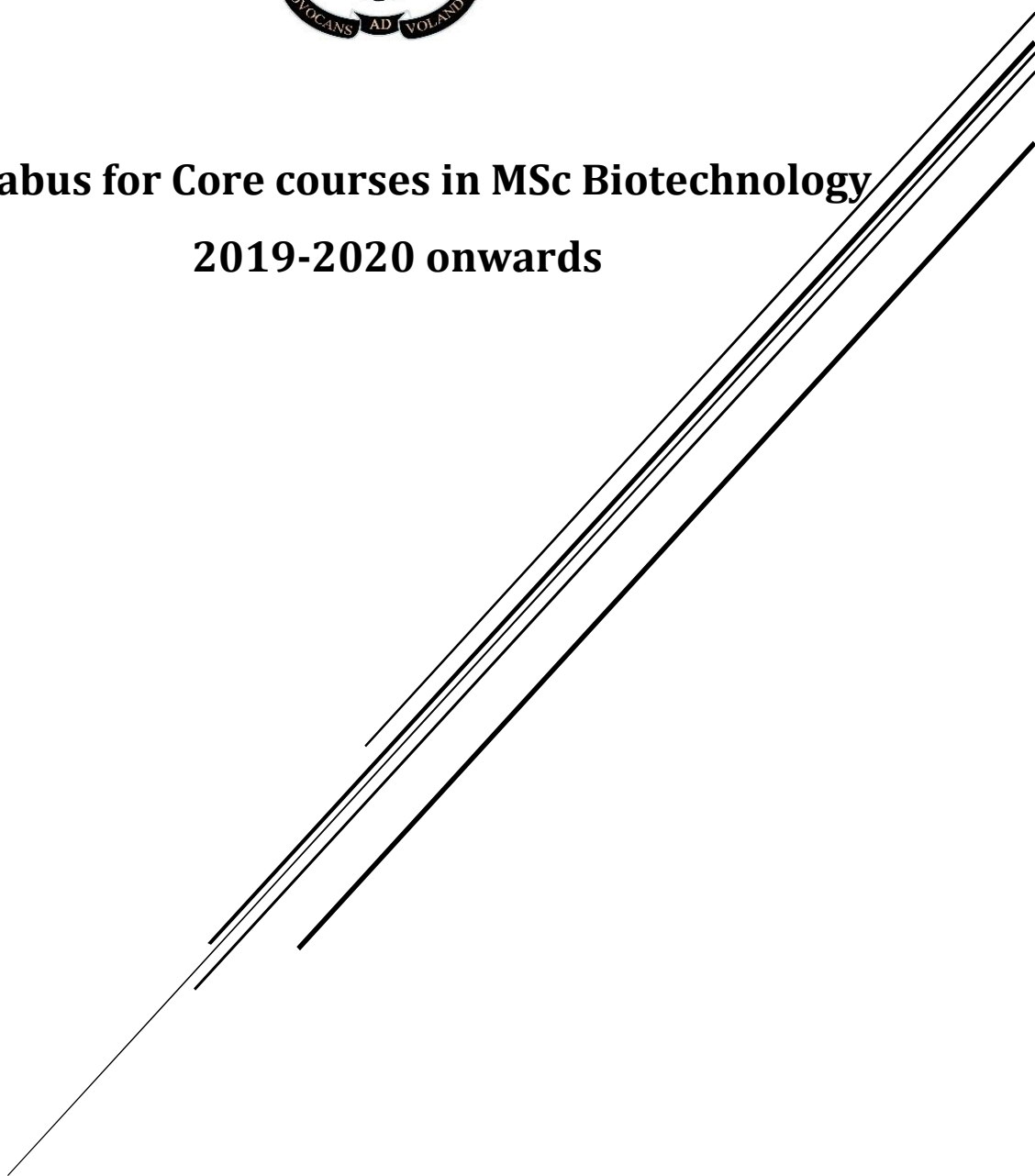


**ST XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI  
POST GRADUATE DEPARTMENT OF BIOTECHNOLOGY**



**Syllabus for Core courses in MSc Biotechnology  
2019-2020 onwards**





**ST. XAVIER'S COLLEGE – AUTONOMOUS, MUMBAI**

**SYLLABUS**

**FOR SEMESTER I COURSES IN BIOTECHNOLOGY**

**(JUNE 2019 ONWARDS)**

### **Contents**

#### **Syllabus for the following courses:**

##### **THEORY COURSES**

SBTS0701	BIOMOLECULES
SBTS0702	IMMUNOLOGY
SBTS0703	GENETICS
SBTS0704	CELLULAR PROCESSES

##### **PRACTICAL COURSE**

SBTS07PR	TECHNIQUES IN BIOTECHNOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
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**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: SEMESTER I      COURSE CODE: SBTS0701      TITLE: BIOMOLECULES**

**NO OF HOURS: 60 (inclusive of self-study)**

**CREDITS: 4**

**COURSE OBJECTIVES:**

The objective is to build upon the base knowledge level regarding biomolecules. The course will emphasise upon the structural features and intermolecular interactions. The course will also introduce the students to recent trends in the understanding of biomolecular structure and interactions.

**UNIT 1:      PROTEIN STRUCTURE AND FOLDING**

**15 lectures**

- Primary structure of proteins and their determination – end group analysis; cleavage of disulphide bond; separation, characterization of polypeptide chain; specific peptide cleavage reactions
- Secondary structure – Ramachandran plot, helical structure, beta structure
- Tertiary structure- fibrous (Collagen) and globular (Myoglobin) structure, Protein stability,
- Quaternary structure – (Haemoglobin) subunit interaction, symmetry, subunit composition determination
- Protein folding: The different pathways of protein folding and its co-relation with protein stability, Molecular chaperons
- Effects of misfolding protein on human diseases; unfolded protein response

**UNIT 2: PROTEIN PURIFICATION AND DENATURATION**

**15 lectures**

- Protein purification:
  - Separation by Precipitation, protein quantification
  - Non-affinity absorption techniques – IXC, Hydroxyapatite chromatography, HIC;
  - Affinity procedures for purifying proteins - Affinity chromatography, Dye ligand, IMAC
  - Non-absorption techniques for purifying proteins- Size exclusion chromatography
  - Monitoring the purity of protein solutions- Electrophoresis of proteins, PAGE, SDS PAGE
- Protein denaturation – temperature, pH-dependent, pressure induced, pressure induced and chemical denaturation, adaptation of Proteins to extreme Environments.

**UNIT 3: DNA TOPOLOGY**

**15 lectures**

- Different forms of DNA, - A/B/C/Z and RL form of double helical DNA, Triple Helix
- Nucleic acid binding protein – Leucine Zipper, Zinc fingers
- OB-fold, Beta Barrel, Helix-turn-helix, Helix-loop-helix
- Linking number, Supercoiling, Topoisomerases
- DNA Packaging: Nucleosomes and Chromatin
- DNA – protein interaction
- Methods to study DNA – protein interaction

**UNIT 4: MEMBRANE ARCHITECTURE**

**15 lectures**

- Membrane Structure and dynamics
  - Composition and Architecture of membrane: lipid types and the lipid bilayer, membrane proteins (integral and peripheral), conformation of membrane proteins, the association of membrane proteins in the lipid bilayer, Hydropathy index
  - Dynamics- lipid movements, flippase, FRAP, Lipid raft, Membrane fusion.
  - Lipid-Protein interactions
  - Liposomes
- Solubilisation of the membrane by using different detergents- Structure and behaviour of detergents, Detergents, and biological membranes

**References:**

- Amit Kessel and Ner Ben Tal, Introduction to proteins (2011), CRC Press, Taylor & Francis Group
- David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003
- Donald Voet and Judith Voet. Biochemistry 3<sup>rd</sup> Ed, John Wiley and sons, Inc publisher, 2004
- J. Berg, J. Tymoczko & L. Stryer, Biochemistry, 5<sup>th</sup>Ed, W. H. Freeman & Company publisher, 2002
- Nelson and Cox, Lehninger's Principles of Biochemistry, fourth edition, Macmillan Worth Publisher, 2004
- Robert K. Scopes, Protein Purification, Springer Science, 1982,
- Philip L. R. Bonner, Protein Purification, Taylor & Francis Group, 2007
- Arthur M Lesk,(1998) Introduction to Protein Science Architecture, Function and Genomics, Oxford publishers.

**ASSESSMENT:**

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: SEMESTER I      COURSE CODE: SBTS0702      TITLE: IMMUNOLOGY**

**NO OF HOURS: 60 (inclusive of self-study)**

**CREDITS: 4**

**COURSE OBJECTIVES:**

The objective is to learn about structural features of components of the immune system as well as their function. The core emphasis will be on the development of the immune system and mechanisms by which the human body elicits an immune response. The course will also introduce the students to recent trends in the field towards diagnostics and therapy.

**UNIT 1: OVERVIEW OF THE IMMUNE SYSTEM**

**15 lectures**

- Haematopoiesis
- Innate immunity: Cells involved, signal transduction pathways, soluble molecules and membrane-associated receptors (Pattern recognition, TLRs, NLRs), Phagocytosis
- Antigens: immunogens, haptens
- Immunoglobulin:
  - fine structure and superfamily
  - Multigene organization of Ig gene, Variable region gene rearrangement and generation of antibody diversity, Class switching among the constant region
- Synthesis, assembly, and secretion of Immunoglobulins

**UNIT 2: IMMUNE EFFECTOR MECHANISMS**

**15 lectures**

- MHC and Regulation of Immune Response:
  - Cellular distribution of MHC molecule
  - Antigen processing and presentation
  - Self - MHC restriction of T cells
  - Presentation of non-peptide antigens
- Activation of B and T lymphocytes
- Complement system: Functions of Complement, Components, Activation, and Regulation.
- Cytokines: Properties, Receptors, Antagonists, Diseases, Therapeutic use of cytokines
- The inflammatory process: the role of neutrophils and other mediators in inflammation, the role of NF-kb and STATs in inflammation, localised, systemic and chronic inflammation and role of anti-inflammatory agents
- Autophagy

**UNIT 3: CLINICAL IMMUNOLOGY**

**15 lectures**

- Hypersensitivity: Type I, II, III, IV hypersensitivity
- Autoimmunity: Organ-specific, systemic, mechanism, treatment
- Tolerance
- Transplantation immunology: Basis of Graft rejection, clinical manifestation of graft rejection, Immune tolerance, Immunosuppressive therapy, and clinical transplantation

- Tumour immunology: tumours of the immune system, Tumour antigens and tumour evasion of the immune system
- Immune response to infectious agents: Bacteria, Virus, Parasites, and Fungi
- Primary and secondary immunodeficiency

#### **UNIT 4 ADVANCES IN IMMUNOLOGY**

**15 lectures**

- Vaccines: Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity, Active and passive immunization; live, killed, attenuated, subunit vaccines; recombinant DNA and protein based vaccines, peptide vaccines, conjugate vaccines; dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (eg Ebola, Zika).
- Immunotherapy for Clinical conditions
- Ag-Ab interaction assays for understanding immune biology, diagnostics, and therapeutics (ELISA, Flow cytometry, SPR, RIA, Immunoprecipitation, Immunofluorescence - cytochemistry, and histochemistry)

#### **References:**

- Abbas, Abul K. & Lichtman, Andrew H.: Cellular and molecular immunology. (5th Ed.) Philadelphia. W.B. Saunders Company, 2003. 0-7216-0008-5--(616.079ABB/LIC)
- Elgert, Klaus D.: Immunology: Understanding the immune system. (2nd edition) Hoboken. John Wiley & Sons, Inc., 2009. 978-0-470-08157-0--(616.079Elg)
- Kuby, Janis: Immunology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-3784-6--(616.079Kub)
- Tizard, Ian R.: Immunology: an introduction. (4th Ed.) Singapore. Thomson Asia Pte Ltd., 2004. 981-243-516-6--(616.079TIZ)
- Janeway, Charles A., Jr.; Murphy, Kenneth & Weaver, Casey: Immunobiology. (9th ed.) New York. Garland Science, 2017. 978-0-8153-4551-0--(616.079Jan)
- Male, David; Brostoff, Jonathan; Roth, David B. & Roitt, Ivan M.: Immunology. (8th ed.) Amsterdam. Elsevier Ltd., 2013. 978-0-7020-4548-6--(616.079Roi)
- Recent trends – research articles.

#### **ASSESSMENT:**

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY CLASS: SEMESTER I**

**COURSE CODE: SBTS0703**

**TITLE: GENETICS**

**NO OF HOURS: 60 (INCLUSIVE OF SELF-STUDY)**

**CREDITS: 4**

**COURSE OBJECTIVES:**

The core objective is to provide in-depth insight on DNA synthesis and transfer of information from genes to RNA to protein. The course will also help in developing an understanding of regulatory mechanisms governing genome activity. An overview of eukaryotic genetics will be also be included in the course.

**UNIT 1: DNA REPLICATION, REPAIR, AND RECOMBINATION 15 Lectures**

- DNA Replication (prokaryotes and eukaryotes) and mutations involved.
- DNA Repair mechanisms
- DNA recombination mechanisms

**UNIT 2: TRANSCRIPTION AND TRANSLATION IN PROKARYOTES AND EUKARYOTES 15 Lectures**

- DNA-Protein interactions during Transcription Initiation and regulation of transcription initiation
- Synthesis of eukaryotic mRNAs by RNA polymerase II, Intron splicing, Processing of Pre-RNA, Degradation of mRNAs
- Synthesis and processing of Non-coding RNAs: Transcript elongation and termination by RNA polymerases I and III, Introns in eukaryotic pre-rRNA and pre-tRN
- Basic mechanisms of RNA to Protein conversion
- Post-translational Processing
- Processing by proteolytic cleavage
- Processing by chemical modification
- Protein Degradation

**UNIT3: REGULATION OF GENE EXPRESSION 15 Lectures**

- Regulation in prokaryotes- operons, riboswitches, antisense RNA
- Eukaryotes:
  - Genome rearrangements, Gene silencing by modification of histones and DNA
  - Transcriptional activators, Co-activators & repressors, enhancers and insulators
  - Regulation of Genome Activity during Development: Vulva development in *Caenorhabditis elegans* and Development in *Drosophila melanogaster*
  - Regulation through RNA interference
  - Concept of Epigenetics

**UNIT 4: EUKARYOTIC GENETICS 15 lectures**

- Yeast genetics: Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and

recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.

- Drosophila genetics: Monohybrid & dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism
- Transmission genetics: single gene inheritance, beyond Mendel's law, genetics of immunity: blood grouping

**References:**

- Griffiths, Anthony J.F., Wessler, Susan R., Lewontin, Richard C. & Gelbart, William M.: An introduction to genetic analysis. (8th Ed.) New York. W.H. Freeman and Company, 2005. 0-7167-4939-4--(575.1GRI)
- Lodish, Harvey F.; Berk, Arnold; Kaiser, Chris A. & Krieger, Monty: Molecular cell biology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-0981-2--(574.87Lod)
- Snustad, D. Peter & Simmons, Michael J.: Principles of genetics. (5th ed.) Hoboken. John Wiley & Sons, Inc., 2010. 0-470-39842-5--(575.1Snu/Sim)
- Brown, T.A.: Genomes 3. New York. Garland Science Publishing, 2007. 0-8153-4138-5--(575.1Bro)
- Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6<sup>th</sup>ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9--(574.88Wat)
- Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter: Molecular Biology of the cell (6<sup>th</sup> Ed) Garland Science Publishing., 2015
- Lewis (2010) – Human genetics: concepts and applications, 9<sup>th</sup> Ed, Tata McGraw- Hill Publishing

**ASSESSMENT:**

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**



**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: SEMESTER I**

**COURSE CODE: SBTS0704**

**TITLE: CELLULAR PROCESSES**

**NO OF HOURS: 60 (INCLUSIVE OF SELF - STUDY)**

**CREDITS: 4**

**COURSE OBJECTIVES:**

The objective is to learn about the basic principles and mechanisms involved in cellular transport and communications. The course will also emphasise on understanding the molecular mechanism of the cell cycle and molecular basis of cancer development.

**UNIT 1: MEMBRANE STUDIES**

**15 Lectures**

- Membrane functions
- Membrane transport: facilitated diffusion (Glut 1) and Primary and Secondary active transport (P, F, ABC, symporter and antiporter)
- Intracellular membrane transport: Transport of molecules between nucleus and cytosol, Endoplasmic reticulum
- Transport across mitochondria and chloroplast
- Transport related to nutrient uptake.

**UNIT 2: BIOSIGNALING**

**15 Lectures**

- Cell signalling pathways that control gene activity-
  - TGF-Beta and activation of Smads, regulation of TGF-Beta by negative feedback loops, cancer and loss of TGF-Beta signalling
  - Activation of gene transcription by seven-spanning cell surface receptors: Wnt and Hedgehog
  - Notch, NF- $\kappa$ b signalling
- Sensory transduction in vision, olfaction, and gustation

**UNIT 3: NEURONAL COMMUNICATION**

**15 Lectures**

- Organization of brain, Anatomy, and functions of a neuron, Ion conducting channels
- Neuronal pathways and Propagation of nerve impulse: Synapses and gap junction, synaptic transmission, Neuromuscular junction: Physiologic anatomy, molecular biology of acetylcholine formation and release, Drugs enhancing and blocking the transmission at NMJ, Myasthenia Gravis
- Neurotoxins, Neurotransmitters

**UNIT 4: CELL CYCLE AND CANCER BIOLOGY**

**15 Lectures**

- Cell cycle phases, Control of mitosis by cyclins, MPF activity and cyclin-dependent kinases, checkpoints in cell cycle regulation
- Apoptosis pathways, its regulation, and techniques to study apoptosis

- Cancer-
  - genetic basis (oncogenes, tumor suppressor genes)
  - Signalling pathways involved (overview)
  - Senescence, telomeres, carcinogens
  - Tumorigenesis, Tumor progression, metastasis
  - EMT

**References:**

- Karl Branden and John Tooze, introduction to Protein structure, 2<sup>nd</sup>ed, garland publishers, 1999.
- Lodish, Harvey F.; Berk, Arnold; Kaiser, Chris A. & Krieger, Monty: Molecular cell biology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-0981-2--(574.87Lod)
- Mathews, Christopher K.; van Holde, K.E. & Ahern, Kevin G.: Biochemistry. (3rd Ed. Indian reprint) Delhi. Pearson Education (Singapore) Pte. Ltd., 2003. 81-297-0215-0--(574.192MAT)
- Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9--(574.88Wat)
- Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter: Molecular Biology of the cell (6<sup>th</sup> Ed) Garland Science Publishing., 2015
- David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003
- Robert A. Weinberg: The Biology of Cancer, 2nd Edition
- John E. Hall, Guyton and Hall Textbook of Medical Physiology (13th Edition)
- Devlin, Thomas M.: Textbook of biochemistry with clinical correlations. [ed. by] (7th ed.) Hoboken. John Wiley & Sons, Inc., 2011. 978-0-470-28173-4--(612.015Dev)

**ASSESSMENT:**

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: SEMESTER I**

**COURSE CODE: MSBTS07PR**

**TITLE: TECHNIQUES IN BIOTECHNOLOGY AND SCIENTIFIC COMMUNICATION SKILLS**

**CREDITS: 8**

**COURSE OBJECTIVES:** The course is designed to teach students the utility of a set of experimental methods in biotechnology in a problem-oriented manner. This course will introduce the students to basic laboratory skills, good laboratory practices and different techniques commonly used in biotechnology experimentation. It will also orient students to learn the basic techniques of separation, quantification, purification, and characterisation of proteins and study the theoretical aspects of proteins and nucleotides using computational tools.

**COURSE CODE: MSBTS07PR**

**Techniques in Biotechnology and Scientific communication Skills**

**Contents:**

1. Introduction to good laboratory practices
2. Laboratory techniques and quality assurances
  - Preparation of solutions and buffers
  - Calibration of instruments: pHmeter, analytical balance, UV-spectrophotometer, colorimeter
  - Calibration of apparatus used for measuring: glass pipettes, auto pipettes and measuring cylinders
  - Validation: Autoclave, Laminar air flow
  - Introduction to principles of Quality assurance and Quality control
3. Microbial techniques: Identification of microorganisms, Sterility testing
4. Nucleic Acid extraction techniques:
  - Extraction of Genomic DNA Extraction from Bacteria, Yeast, human samples (Cheek cells, Blood) and quantification of biomolecules using UV (nucleic acids and proteins)
  - Isolation of RNA from yeast/ E. coli
5. Immunological techniques:
  - Isoagglutination titre study
  - Single Radial Immunodiffusion
  - Dot-ELISA/ Antibody/ antigen capture ELISA
  - Western Blot Technique
6. Techniques in Protein Chemistry:
  - Protein Estimation using the following methods:
    - ✓ Biuret assay
    - ✓ Bradford's assay
    - ✓ Folin-Lowry assay
  - Protein Separation and Purification techniques:
    - ✓ Polyacrylamide gel electrophoresis (native and SDS)
    - ✓ Horizontal gel electrophoresis (Slide and Slab)
  - Protein gel staining techniques:
    - ✓ Coomassie brilliant blue, Silver staining, TCA and Ponceau staining

- ✓ Activity staining: LDH
- Protein Purification techniques:
  - ✓ Protein Precipitation
  - ✓ Ion exchange Chromatography
  - ✓ Gel filtration
  - ✓ Affinity Chromatography
  - ✓ Study of purified Immunoglobulins using SDS PAGE
- Viscosity studies of proteins
- 7. Introduction to computational tools in biology:
  - Retrieval of protein, nucleotide and protein structural data for analysis
  - Protein sequence analysis
  - Primary protein sequence analysis
  - Secondary sequence analysis
  - Tertiary structure analysis
- 8. Scientific communication:
  - Gathering scientific data from various sources.
  - Written communication: Guide to clear writing, forms and styles of writing
  - Scientific publication writing
  - Oral communication variants
  - Concept of Plagiarism

#### References:

1. Rodney Boyer, Biochemistry Laboratory (2<sup>nd</sup> Ed, 2012), Pearson's Publication
2. Shepler J and Cassin P, Biotechnology explorations (2000), ASM Press
3. Segel, Irwin H.: Biochemical calculations: how to solve mathematical problems in general biochemistry. (2nd Ed.) Singapore. John Wiley & Sons (Asia) Pte. Ltd., 2004. 9812-53-149-1--(574.1920151SEG)
4. Wilson, Keith & Walker, John: Principles and techniques of biochemistry and molecular biology. [ed. by] (7th ed.) Cambridge. Cambridge University Press, 2010 (2013). 978-0-521-73167-6--(574.19285Wil/Wal)
5. Anthony Wilson, Handbook of Science Communication, IOP Publishing Ltd. CRC Press (1999)
6. Online resources
7. Relevant SOPs from USP and IP

#### Assessment:

**CIA: 80M**

**ESE: 120M**



**St. Xavier's College – Autonomous, Mumbai**

**Syllabus**

**For Semester II Courses in M.Sc. in Biotechnology**

**(November 2019 onwards)**

**Contents**

**Syllabus for the following courses:**

**THEORY COURSES**

SBTS0801	METABOLISM
SBTS0802	ANIMAL BIOTECHNOLOGY
SBTS0803	MOLECULAR BIOTECHNOLOGY
SBTS0804	ADVANCED ANALYTICAL TECHNIQUES

**PRACTICAL COURSE**

SBTS08PR	BIOTECHNOLOGY
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**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: SBTS0801**

**TITLE: METABOLISM**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The objective is to build upon the base knowledge level regarding biochemical principles with emphasis on different metabolic pathways in microbes, animals, and plant systems.

The course will introduce students to the concept of pathway modulations for diagnostics and industrial applications.

**UNIT 1: PHOTOSYNTHESIS**

**15 lectures**

- Overview of Photosynthesis, light absorption and energy conversions, electron pathways in chloroplast membranes, ATP synthesis, organisation, and regulation of photosynthetic complexes.
- Carbon dioxide fixation, regulation (Calvin -Benson cycle), and variations in fixation mechanisms.
- Respiration and Photorespiration

**UNIT 2: PLANT METABOLISM**

**15 lectures**

- Metabolism: Types of metabolic pathways, the main class of metabolic reactions (using few already studied pathways)
- Carbohydrate metabolism in plants (sucrose and Starch)
- Overview of plant secondary metabolism - Main Secondary metabolites, Function of Secondary Metabolites (alkaloid, terpenoids, phenolics)
- Compartmentation of SMs biosynthesis- Cytosol, Mitochondria, Vesicles, Endoplasmic reticulum: chloroplast

**UNIT 3: ANIMAL METABOLIC PATHWAYS AND THEIR CLINICAL RELEVANCE**

**15 lectures**

- Pentose phosphate pathway
- Uronic acid production and importance
- Metabolism of other important sugars – fructose
- Nucleotide metabolism: purine and pyrimidine
- Essential fatty acids – Sources, Biosynthesis, actions of EFAs and their metabolites (cell membrane fluidity, second messenger action, EFAs in various pathological processes etc)
- Biochemical role of vitamins and minerals as coenzymes and cofactors

**UNIT 4: MICROBIAL METABOLISM AND ITS SIGNIFICANCE**

**15 lectures**

- Amino acid metabolism and metabolic intermediates
- Integration of amino acid metabolites into the central metabolic pathway

- Systems /metabolic engineering strategies for the production of amino acids
  - Pathway-focused approaches; Systems biology-based approaches; Evolutionary approaches e.g.: Amino acids like threonine, glutamate, lysine, and tryptophan using microbial systems.
- Integration of fatty acid metabolism into central metabolic pathways.
- Mechanism of Nitrogen fixation using a bacterial system.
- Overview of glycan metabolism and importance

### References:

- Cseke L.J., Kirakosyan A., Kaufman P.B., Warber S.L., Duke J.A. and Brielmann H.L. Natural Products from Plants, 2nd edition, Taylor & Francis group, 2006.
- Voet, Donald & Voet, Judith G.: Biochemistry. (4th ed.) Hoboken. John Wiley & Sons (Asia) Pte. Ltd., 2011. 1-1180-25024--(574.192Voe/Voe)
- Stryer, Lubert; Berg, Jeremy M.; Tymoczko, John L. & Gatto, Gregory J.: Biochemistry. (7th ed.) New York. W.H. Freeman and Company, 2012. 1-4292-7635-5--(574.192Str)
- Buchanan B; Gruissem W *et al* (2<sup>nd</sup> Ed.) Biochemistry and Molecular Biology of Plants John Wiley & Sons 2015,
- Lehninger, Albert L.: Principles of Biochemistry. (6th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4292-3414-6--(574.192Leh)
- Rodwell, Victor W.; Bender, David A.; Botham, Kathleen M. & Kennelly, Peter J.: Harper's Illustrated Biochemistry. (30<sup>th</sup> ed.) New York. Mcgraw-Hill, 2015.978-1-25-925286-0--(612.015Har)
- Devlin, Thomas M.: Textbook of biochemistry with clinical correlations. [ed. by] (7th ed.) Hoboken. John Wiley & Sons, Inc., 2011. 978-0-470-28173-4--(612.015Dev)

### ASSESSMENT:

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: SBTS0802**

**TITLE: ANIMAL BIOTECHNOLOGY**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The course will provide an overarching view of concepts in cell development. It will also illustrate the potential of animal cells, organ engineering, and genetic engineering in therapeutics.

**UNIT 1: BIOLOGY OF CELL DEVELOPMENT**

**15 lectures**

- Cell differentiation into cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell motility and migration.
- Embryonic development stages [fertilisation, post fertilisation, Implantation]
- Establishment of germ layers and their fate
- Immune response to developing embryo.

**UNIT 2: ANIMAL CELL CULTURE**

**15 lectures**

- Biology of cultured cells, Transformation, immortalisation, and Differentiation
- Primary Culture and development of cell lines – normal and tumor
- Characterisation of cells in culture and maintenance of cells in culture: subculture, contamination, and cryopreservation
- 3-D culture: organ culture, histotypic culture, and organotypic culture

**UNIT 3: STEM CELLS AND TISSUE ENGINEERING**

**15 lectures**

- Types of stem cells: ES, Adult, iPSCs, Cancer stem cells
- Characterisation of stem cells
- Applications of stem cells in therapeutics
- Ethical issues and regulations in stem cell research
- Fundamentals of tissue engineering: Growth Factors, morphogens, Extracellular Matrix, Cell adhesion and migration, Inflammatory and Immune responses to tissue engineered devices.
- Biomaterials: Polymeric scaffolds, Calcium Phosphate Ceramics, Biomimetic materials
- Introduction of 3-D organ printing, organ on chip
- Applications of tissue engineering

**UNIT 4: ADVANCES IN ANIMAL BIOTECHNOLOG**

**15 lectures**

- Cell line models in biomedical research
- *In vitro* testing (cytotoxicity)
- Scale up in cell culture (types of bioreactors for suspension and monolayer cultures and process control)



- Therapeutic peptides/ Biosimilars- Production methodology
  - Insulin
  - Tissue plasminogen activator
  - Interferon – alpha, Erythropoietin
  - Vaccines
  - Monoclonal antibodies (Antibody engineering)
- Animal models in biomedical research

**References:**

- Lodish, Harvey F.; Berk, Arnold; Kaiser, Chris A. & Krieger, Monty: Molecular cell biology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-0981-2-- (574.87Lod)
- Alberts, Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter: Molecular Biology of the cell (6<sup>th</sup> Ed) Garland Science Publishing., 2015
- Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
- Daan J. A. Crommelin, Robert D. Sindelar. (2002) Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists. Taylor & Francis.
- Gary Stein and Maria B *et al.* (2011) Human Stem Cell Technology and Biology. Wiley Blackwell.
- GordanaVunjak-Novakovic, R. Ian Freshney. (2006) Culture of Cells for Tissue Engineering. John Wiley & Sons.
- Inderbir Singh & GP Pal. (2007) Human Embryology. MacMillan Publishers.
- Kaushik Deb and Satish Totey. (2009) Stem Cells Basics and Applications. Tata McGraw Hill.
- R. Ian Freshney, Glyn N. Stacey, Jonathan M. Auerbach. (2007) Culture of Human Stem Cells. John Wiley & Sons
- Robert Lanza, Robert Langer, Joseph P. Vacanti. (2011) Principles of Tissue Engineering. Academic Press.
- Scott F Gilbert. (2000) Developmental Biology, 6th edition. Sinauer Associates.
- Thomas W. Sadler. (2009) Langman's Medical Embryology. Lippincott Williams & Wilkins.

**ASSESSMENT:**

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: SBTS0803**

**TITLE: MOLECULAR BIOTECHNOLOGY**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The important structural and functional aspects of the genome will be illustrated to the students through this course. The objective of this course is to introduce various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries.

**UNIT 1: GENOMES AND GENOME MAPPING 15 Lectures**

- A brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria, and chloroplast
- Genome mapping: molecular markers; physical mapping methods (sequencing, RM, STS), cytogenetic techniques, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping
- Methods of genome analysis: Polymorphisms in DNA sequence, Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing of large genomes
- Genome sequencing projects: Human Genome Project, genome sequencing projects for microbes, plants, and animals, accessing and retrieving genome project information from the web.

**UNIT 2: GENOME ANALYSIS 15 Lectures**

- Comparative genomics: Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand the evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in the genome sequence.
- Functional genomics - Transcriptome analysis for identification and functional annotation of the gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in a genome, gene function- forward and reverse genetics.
- Model organisms: *S. cerevisiae*, *C. elegans*, *D. melanogaster*, *M. musculus*, *D. rerio*
- Genomics and medicine

**UNIT 3: TOOLS FOR GENE MANIPULATION 15 lectures**

- Cloning tools:
  - Enzymes
  - Vectors: Expression vectors, Vectors for making RNA probes, Tools for cloning and expression in prokaryotic and eukaryotic systems
  - PCR techniques

- Gene silencing and genome editing technologies: Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts, genome editing using enzymes.

**UNIT 4: APPLICATION OF MOLECULAR BIOTECHNOLOGY      15 lectures**

- Plant engineering: abiotic and biotic stress, modification of nutrient content
- Synthesis of commercial products - Restriction Endonucleases
- Chloroplast engineering
- Protein Engineering- rational and random

**References:**

- Lewin, Benjamin; Krebs, Jocelyn E.; Goldstein, Elliott S. & Kilpatrick, Stephen T.: Genes XI. New Delhi. Jones and Bartlett India Pvt. Ltd., 2015. 978-93-80853-71-0--(575.1Lew)
- Glick, Bernard R., Pasternak, Jack J. & Patten, Cheryl L.: Molecular biotechnology: principles and applications of recombinant DNA. (4th ed.) Washington, D.C. ASM Press, 2010. 1-55581-498-4--(660.6Gli)
- Cooper, Geoffrey M. & Hausman, Robert E.: The cell: a molecular approach. (6th ed.) Sunderland. Sinauer Associates, Inc., 2013. 978-0-87893-964-0--(574.87Coo/Hua)
- Primrose, S.B. & Twyman, R.M.: Principles of gene manipulation and genomics. (7th ed.) Malden. Blackwell Publishing, 2006. 1-4051-3544-3--(575.1Pri/Twy)
- Sambrook, Joseph & Russell, David W.: Molecular cloning: a laboratory manual. [Vol.1-3] (3rd Ed.) Cold Spring Harbor. Cold Spring Harbor Laboratory Press, 2001. 0-87969-577-3--(574.873224SAM/RUS)
- Brown, T.A.: Gene cloning and DNA analysis: an introduction. (7th ed.) Chichester. John Wiley & Sons Ltd., 2016. 978-1-119-07256-0--(574.873282Bro)
- Watson, James D., Baker, Tania A., Bell, Stephen P. & Gann, Alexander: Molecular biology of the gene. (6th ed.) New York. Pearson Education Inc., 2008. 0-321-50781-9--(574.88Wat)
- Relevant current research articles
- Suggested reading: My genome by Craig Venter.

**ASSESSMENT:**

**Continuous Internal Assessment (CIA) = 40%**

**End Semester Assessment (ESE) = 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: SBTS0804**

**TITLE: ADVANCED ANALYTICAL TECHNIQUES**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The course is broad-based inclusive of several new techniques that current experimental researchers are employing to answer complex questions in biology.

**UNIT 1: ANALYTICAL TECHNIQUES**

**15 lectures**

Basic principles, instrumentation, and applications of the following:

- Fluorescence spectroscopy
- ORD, CD spectroscopy
- NMR and ESR
- X-Ray Crystallography: Principles, instrumentation, and application

**UNIT 2: ADVANCED ANALYTICAL TECHNIQUES**

**15 lectures**

- Advanced Microscopy: Different versions of advanced microscopy, electron microscopy, and confocal microscopy
- Advances in Chromatography
- Biosensors: applications in diagnostics, environment, and industry
- Molecular diagnostics: PCR and Hybridisation based

**UNIT 3: NANOTECHNOLOGY IN MEDICINE**

**15 lectures**

- Introduction to Nanotechnology: nanotechnology and bio-nanotechnology, important nanoparticles / materials, bio nanorobots/molecular motors nanomotors and their uses
- Synthesis and characterization of nanoparticles: Common Strategies with examples
- Applications of nanotechnology:
  - Medical nanotechnology, Nano-diagnostics: Nanoparticles for the detection and treatment of cancer, Nanoarrays for molecular diagnostics, Nanoparticles for Molecular Diagnostics, Nano barcode
  - Nanopharmaceuticals: Nanobiotechnology for drug discovery and drug delivery
  - Role of nanotechnology in biological therapy, nanodevices in medicine and surgery

**UNIT 4: PROTEOMICS**

**15 lectures**

- Aims, strategies, and challenges in proteomics; proteomics technologies: 2D-PAGE DIGE, isoelectric focusing, mass spectrometry (iTrac, SELDI, LCMS), MALDI-TOF, proteome databases.
- Protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics

**References:**

- Bartlett & Stirling, PCR protocols, 2<sup>nd</sup>ed., Humana publishers
- Daniel M, Basic Biophysics 2004, Student Edition
- David Spector and Robert Goldman, Basic methods in microscopy. Cold spring harbour laboratory press, 2006
- Voet, Donald & Voet, Judith G.: Biochemistry. (4th ed.) Hoboken. John Wiley & Sons (Asia) Pte. Ltd., 2011. 1-1180-25024--(574.192Voe/Voe)
- Chandler, Douglas E. & Roberson, Robert W.: Bioimaging: current concepts in light and electron microscopy. Sudbury. Jones and Bartlett Publishers, 2009. 0-7637-3874-7--(578Cha/Rob)
- Cotterill, Rodney M.J.: Biophysics: an introduction. Singapore. John Wiley & Sons (Asia) Pte. Ltd., 2003. 9812-53-008-8--(574.191COT)
- Skoog, Douglas A.; Holler, F. James & Crouch, Stanley R.: Principles of instrumental analysis. (6th ed. Indian Reprint) Delhi. Cengage Learning India Private Limited, 2007(2015). 978-81-315-2557-9--(543.08Sko)

**ASSESSMENT:**

- **Continuous Internal Assessment (CIA) = 40%**
- **End Semester Assessment (ESE) = 60%**

## **SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER II**

**COURSE CODE: SBTS08PR**

**TITLE: Biotechnology**

**Credits: 8**

### **• Course Objectives:**

The course is designed to teach students the utility of set of experimental methods in biotechnology in a problem-oriented manner. This course will introduce the students to learn the basic techniques for understanding metabolism, recombinant DNA technology and basic techniques in animal cell culture.

### **Contents:**

#### **I. Experimental aspects in Metabolism**

1. Study of Vitamins as Participants of Enzyme Reactions
2. Study of Biological oxidation – e.g.: NADH-dehydrogenase activity determination
3. Study of Krebs Cycle intermediates, enzymes, Glucose-6-phosphate dehydrogenase activity
4. Oxidative metabolism – ATP detection, ATPase activity determination
5. Nucleotide metabolism – Uric acid determination
6. Factors influencing/ affecting the intermediate metabolism in microbes.
7. Alcohol production
8. Plant metabolism study –
  - a. Chloroplast separation
  - b. Pigment separation and quantification of plant pigments
  - c. Proton uptake assays
9. Secondary metabolite study
10. Study of fatty acids

#### **II. Molecular Biology**

1. Creation of genomic library: Isolation of genomic DNA and Plasmid DNA, Restriction Digestion, Ligation and Transformation
2. Expression of recombinant proteins
3. PCR amplification of 16srRNA
4. RFLP analysis
5. Preparation of glycerol stocks

#### **III. Animal Cell Culture:**

1. General aseptic techniques and preparation for ACC
2. Media preparation for ACC
3. Primary culture using chick embryo.
4. Subculture of cell lines
5. Karyotyping and G- Banding using human blood cells.  
Data interpretation

#### **IV. Data interpretation of the following techniques**

1. HPLC and Gas chromatography
2. 2D /DIGE electrophoresis and Mass spectrometry

#### **V. Genome study:**

- Exploration of metabolic pathway databases e.g.: KEGG, Reactome
- Exploration of enzyme databases

- DNA sequencing study – Nucleotide, Gene sequences databases
- Gene/nucleotide sequence analysis- gene finding, DNA motif analysis, intron-exon finder, Using Bioedit for nucleotide sequence analysis.
  
- Molecular biology experiments
  - Primer designing and validation – Primer validation.
  - Study of *in silico* restriction digestion
  - Study of Cloning vectors
- Exploration of genome databases
- Exploration of proteome databases

**References:**

- Molecular Cloning: Laboratory Manual Vol I, 2001, Joseph Sambrook, David William Russel, CHL Press
- Freshney, R. Ian: Culture of animal cells: a manual of basic technique and specialized applications. (6th ed.) Hoboken. John Wiley & Sons, Inc., 2010. 978-0-470-52812-9--(591.0724Fre)
- Wilson, Keith & Walker, John: Principles and techniques of biochemistry and molecular biology. [ed. by] (7th ed.) Cambridge. Cambridge University Press, 2010(2013). 978-0-521-73167-6--(574.19285Wil/Wal)
- Godkar, Praful B. & Godkar, Darshan P.: Textbook of medical laboratory technology: Clinical laboratory science and molecular diagnosis. [Vol. I & II, ed. by] (3rd ed.) Mumbai. Bhalani Publishing House, 2014. 978-93-81496-19-0--(616.01God/God)
- Boyer, Rodney F.: Modern experimental biochemistry. (3rd ed.) Delhi. Pearson Education, Inc., 2000. 81-7808-239-X--(574.19285BOY)
- Wilson, Keith & Walker, John: Principles and techniques of biochemistry and molecular biology. [ed. by] (7th ed.) Cambridge. Cambridge University Press, 2010(2013). 978-0-521-73167-6--(574.19285Wil/Wal)
- Online resources

**ASSESSMENT:**

**CIA: 80M**

**End Semester Exam: 120M**



**St. Xavier's College – Autonomous, Mumbai**

**Syllabus**

**For Semester III Courses in M.Sc. in Biotechnology**

**(June 2019 onwards)**

**Contents**

**Syllabus for the following courses:**

**THEORY COURSES**

SBTS0901      BIOSTATISTICS AND BIOINFORMATICS

MSBTS0902    DRUG DEVELOPMENT

SBTS0903      BIOPROCESS TECHNOLOGY

SBTS0904      ENVIRONMENTAL BIOTECHNOLOGY

**PRACTICAL COURSES**

SBTS09PR      BIOINFORMATICS AND RESEARCH METHODOLOGY



**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER III**

**COURSE CODE: SBTS0901**

**TITLE: BIOSTATISTICS AND BIOINFORMATICS**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The Biostatistics module will introduce students to the science of collecting and analysing numerical data for study designs and basic methods for testing the various hypothesis with emphasis on parametric and nonparametric tests. The Bioinformatics module is designed to provide theory and practical experience of the use of computational tools and databases to investigate molecular biology and evolution related concepts.

**UNIT 1: INTRODUCTION TO BIOSTATISTICS**

**15 lectures**

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

**UNIT 2: APPLIED BIO-STATISTICS**

**15 lectures**

- Statistical Experimentation: Introduction, test, control
- Experimental design and terms
- Theory of probability, density function (Estimation etc.)
- The standard Normal distribution
- Hypothesis Testing: step, errors
- Non-parametric tests: Sign, Wilcoxon, and Mann- Whitney test
- Use of R programme

**UNIT 3: DATABASES AND SEQUENCE ALIGNMENT**

**15 lectures**

- Introduction to Programming Languages in Bioinformatics
- Biological databases:
  - Study of biological databases - Concept of databases, classification
  - Submission of sequences to the databases
  - Biological data retrieval and study of data formats
  - Pitfalls of biological databases and annotations of biological data File formats and
  - The biological database management system
- Sequence alignment:
  - Pairwise sequence alignment, Multiple sequence alignment, Phylogenetic analysis, and importance

#### **UNIT 4 PROTEIN SEQUENCE AND STRUCTURE ANALYSIS 15 lectures**

- Protein secondary and tertiary structures
- Protein structure analysis
  - Protein structure databases, Structure descriptors, protein structures
  - Protein structure visualization, comparison, and importance
- Protein functions
  - Analysing structure-function relationships, classification, and assignment of protein function: The Enzyme Commission; The Gene Ontology Consortium protein function classification, Allergenic Protein Databases and Protein-Allergenicity Prediction, Prediction of Post-Translational Modification and Sorting

#### **Reference Books:**

- Wayne W Daniel (1999), Biostatistics: a foundation for analysis in health sciences, John Wiley, and sons
- N Gurumani (2004), Introduction to Biostatistics, MJP Publishers.
- David Mount (2004) Bioinformatics: Sequence and Genome Analysis. 2<sup>nd</sup> edition, Cold Spring Harbor Laboratory Press, New York.
- Jonathan Pevsner (2009) Bioinformatics and Functional Genomics. 2<sup>nd</sup> edition, John Wiley and Sons, New Jersey.
- Teresa K. Attwood and D. J. Parry Smith (1999) Introduction to Bioinformatics. 1<sup>st</sup> edition, Pearson Education Limited, England
- 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
- Arthur M. Lesk (2005) Introduction to Bioinformatics, 2<sup>nd</sup> edition Oxford University Press
- Jian Xiong (2006), Essential Bioinformatics, 1<sup>st</sup> edition, Cambridge university press,

#### **ASSESSMENT:**

**Continuous Internal assessment :40%**

**End Semester Assessment: 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER III**

**COURSE CODE: SBTS0902**

**TITLE: DRUG DEVELOPMENT**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The course will provide an insight into the research and development carried out in drug discovery. The core of this course will encompass the journey of a drug from bench to bedside.

**UNIT 1: DRUG DEVELOPMENT**

**15 lectures**

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

**UNIT 2: PRECLINICAL ASPECTS OF DRUG DEVELOPMENT**

**15 Lectures**

- Principles of pharmacokinetics and pharmacodynamics
  - intestinal absorption, metabolic stability, drug-drug interactions, plasma protein binding assays, metabolite profile studies
- Principles of toxicology: Reproductive toxicity and teratogenicity, Mutagenicity, carcinogenicity, and other tests
- Experimental design for preclinical and clinical PK/PD studies
  - *In vitro* preclinical tests
  - Selection of animal model
  - The scope of GLP, SOP for the conduct of clinical & non-clinical testing

**UNIT 3: CONSIDERATIONS DURING BIOPHARMACEUTICALS  
MANUFACTURING**

**15 lectures**

- Guides to good manufacturing practice  
The manufacturing facility, clean rooms, Cleaning, decontamination, and sanitation (CDS), Water for biopharmaceutical processing
- Microbiological considerations and Excipients
- Delivery systems
- Product analysis:
  - Protein-based contaminants
  - Removal of altered forms of the protein of interest from the product stream

- Detection of protein-based product impurities
- Immunological approaches to detection of contaminants
- Endotoxin and other pyrogenic contaminants
- Microbial and viral contaminants
- Miscellaneous contaminants
- Validation studies
- Labelling and Packaging

**UNIT 4: CLINICAL RESEARCH AND REGULATORY AFFAIRS**                      **15 lectures**

- Introduction, Good clinical practice guidelines, Ethical aspects of clinical research
- Clinical research methodologies and data management, Regulatory requirements
- Pharmacovigilance: Adverse Events and Classifications, Pharmacovigilance methods  
Adverse drug reaction reporting
- Drug safety: the role of FDA and ICH, Investigational New Drug Applications

**References:**

- Ed. Hardman G Limbird LE (2001) “Goodman Gillman’s The Pharmacological Basis of Therapeutics” McGraw Hill Press
- Daan J. A. Crommelin, Robert D. Sindelar. (2002) Pharmaceutical Biotechnology: An Introduction for Pharmacists and Pharmaceutical Scientists. Taylor & Francis.
- Gary Walsh. (2006) Biopharmaceuticals: Biochemistry and Biotechnology. John Wiley & Sons.
- Gary Walsh. (2007) Pharmaceutical Biotechnology Concepts and Applications John Wiley & Sons.
- Oliver Kayser, Rainer H. Müller. (2006) Pharmaceutical Biotechnology. John Wiley & Sons.
- Thomas M. Jacobsen, Albert I. Wertheimer. (2010) Modern Pharmaceutical Industry: Primer. Jones & Bartlett Publishers.
- Tommy Liljefors, Povl Krogsgaard-Larsen, Ulf Madsen. (2010) Textbook of Drug Design and Discovery. 4<sup>th</sup> Edition. CRC Press
- [https://www.who.int/biologicals/good\\_manufacturing\\_practice](https://www.who.int/biologicals/good_manufacturing_practice)

**ASSESSMENT:**

**Continuous Internal assessment :40%**

**End Semester Assessment: 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER III**

**COURSE CODE: SBTS0903**

**TITLE: BIOPROCESS TECHNOLOGY**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The course aims at educating students about the strategies employed in process industries and its implementation into biological systems to produce valuable biotech-based metabolites. The engineering concepts including cell growth kinetics, process design, and transport operation will be covered during the course.

**UNIT 1: PRINCIPLES OF BIOPROCESS TECHNOLOGY**

**15 lectures**

- 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 AND OPERATIONS**

**15 lectures**

- 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.
- Enzyme Technology in Food manufacture and Processing: Mechanisms of enzymatic reactions and bioconversions (e.g., hydrolysed protein); associated downstream processing (e.g., de-oxygenation and de-sugaring); case studies (e.g., Cheese making)
- Microbial technology in food production process and operations: Role of microbial fermentation in food and beverages; food ingredients and additives prepared via microbial fermentation, bioconversion from food wastes to useful products; food preservation via microbes.

**UNIT 3: DOWNSTREAM PROCESSING**

**15 lectures**

- Flocculation and floatation
- Filtration
- Centrifugation
- Cell disruption
- Liquid extraction
- Precipitation and Adsorption
- Dialysis and Reverse osmosis
- Chromatography
- Crystallization and drying

#### UNIT 4: INDUSTRIAL PRODUCTS

15 lectures

- Polysaccharides/ biopolymers/micro-polymers- Xanthan gum, Dextran
- Enzymes – proteases, amylases, pectinases, lipases
- Antibiotics
- Vitamin B<sub>12</sub>
- Amino acids and alcohols
- *Invitro* systems and bioprocess technology for industrial production of secondary metabolites- Cell suspension cultures (Bioreactors), Immobilized cell systems, Hairy root cultures, enhancement of SM yield

#### References:

- Glazer A.N. & Nikaido H. (1995) Microbial Biotechnology: Fundamentals of Applied Microbiology. W.H. Freeman & Company, New York.
- Michael L. Shuler, Fikret Kargı (1992) Bioprocess Engineering: basic concepts. Prentice Hall Publishers. New York.
- Stanbury P.F., Whitaker A, Hall S.J. (1999) Principles of Fermentation Technology. 2<sup>nd</sup> edition, Butterworth-Heinemann
- Wulf Crueger and Anneliese Crueger (1990) Biotechnology: A Textbook of Industrial Microbiology. Panima Publishers. New Delhi
- Karl-Hermann Neumann, Ashwani Kumar, Jafargholi Imani, 2009, Plant Cell and Tissue Culture - A Tool in Biotechnology, Basics, and Application, Springer-Verlag Berlin Heidelberg
- Razdan, M.K.: Introduction to plant tissue culture. (2nd Ed.) New Delhi. Oxford & IBH Publishing Co. Pvt. Ltd., 2003. 81-204-1571-X--(581.0724RAZ)

#### ASSESSMENT:

- **Continuous Internal assessment :40%**
- **End Semester Assessment: 60%**

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER III**

**COURSE CODE: SBTS0904**

**TITLE: ENVIRONMENTAL BIOTECHNOLOGY**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The course includes biotechnology-based solution aspects for environmental issues. An overview of quality, ethical and safety aspects of genetically modified products is also included in the coursework. The course aims for the student to understand concepts and strategies related to nutraceutical and functional foods production and applications.

**UNIT 1: ENVIRONMENTAL POLLUTION AND BIOREMEDIATION 15 lectures**

- Environmental pollution: urban aspects (biomedical waste, e waste, solid waste)
- Environmental Monitoring: concepts, strategies, and applications of nanotechnology
- Biofouling and biodeterioration: agents and protection methods
- Bioremediation: Biodegradation and bioconversion of natural and xenobiotic compounds
- Phytoremediation overview, microbially assisted phytoremediation, phytoremediation of saline soil, genetic strategies for advancing phytoremediation potential in plants.
- Heavy Metal Bioremediation- conventional and advanced methods
- Oil pollution remediation.

**UNIT 2: ENVIRONMENTAL SUSTAINABILITY 15 lectures**

- Concept of sustainability, carbon footprint and credits
- Biomass management
- Sustainability in agriculture: Bio-pesticides, Bio-fertilizers, and Integrated Pest management
- Energy and Environment: Bioenergy
- Metagenomics: concept, strategies, and applications in environmental biotechnology

**UNIT 3: GM CROPS AND NUTRACEUTICALS 15 lectures**

- GM crops- national and global scenario (*Bt* based & others and fallacies associated)
- GM based phytonutrients.
- Food security dilemma- GM food Vs Organic food
- Nutraceuticals and Functional Foods: Nutraceuticals and Functional Foods- Definition, characteristic features, and classification; Sources (with examples e.g., microbes, plants, algae); Applications of nutraceuticals in human health and nutrition- health effects of commonly used nutraceuticals and functional foods (case studies), Safety and Regulatory guidelines

#### **UNIT 4: SAFETY, ETHICS AND QA ASPECTS IN BIOTECHNOLOGY 15 lectures**

- Biosafety- history, Need for containment and levels (microorganisms, plants, and animals – both GMOs and LMOs), primary containment of biohazards, BSCs, Clean Room technology
- Regulatory guidelines: both national and International for food and food ingredients produced using GMOs, GM crops and livestock.
  - Cartagena Protocol, Role of IBSC, RCGM, GEAC, and others
  - Safety and Environment Impact concerns with respect to GMOs, LMOs, GM foods, Crops and Livestock, Risk assessment, management and communication including GMP, GLP, and HACCP, Generally, Recognised as Safe (GRAS)
- Bioethical conflicts in Biotechnology: ELSI of HGP, Ethical concerns in GM utilized for consumption, agricultural benefits, or human therapy.
- Quality assurance and validation: concept, documentation – SOPs
- ISO aspects

#### **Reference Books:**

- A.G. Murugesan and C. Rajakumari (2006) Environmental Science and Biotechnology Theory and techniques MJP Publishers, Chennai
- Alan H. Scragg (2006) Environmental Biotechnology, 1<sup>st</sup> edition, Oxford University Press
- Alexander N. Glazer and Hiroshi Nikaido (2010) Microbial Biotechnology, 2<sup>nd</sup> edition, Cambridge University Press.
- Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
- Rajul K Gupta (2017) Food Safety in the 21<sup>st</sup> Century: Public Health Perspective, Academic Press Elsevier.
- Biosafety in Microbiology and biomedical laboratories, 5<sup>th</sup> Ed. (2009): CDC, NIH publication. HHS publication (21-1112)
- Gareth M. Evans and Judith C. Furlong (2003) Environmental Biotechnology Theory and Application, John Wiley & Sons Inc.
- Gwendolyn Holmes Bruce *et al*, (2000), Handbook of Environmental management and technology, Wiley Interscience Publishers
- <http://dbtbiosafety.nic.in>
- 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*
- Indu Shekhar Thakur (2006) Environmental Biotechnology: Basic Concepts and Applications, I. K. International Pvt Ltd, 2006



- 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.
- S.K. Agarwal (2007) Environmental Biotechnology, APH Publishing Co-operation New Delhi
- Secretariat of the Convention on Biological Diversity (2000). Cartagena Protocol on Biosafety to the Convention on Biological Diversity: text and annexes. Montreal.
- Traavik. T and Lim Li Ching, (2007): Biosafety first. Tapir Academic Press
- Recent research articles.

**ASSESSMENT:**

**Continuous Internal assessment (40M)**

CIA I & CIA II: Field Study Report Presentation

<b>End Semester Exam Pattern:60 Marks:</b>		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
<b>100 Marks:</b>		
No. of Units	No. of Questions	Marks per Question
4	5 – 1 from each Unit &1 based on all units	20 marks per question.

**SUBJECT (PRACTICALS): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER III**

**COURSE CODE: SBTS09PR**

**Title: BIOINFORMATICS AND RESEARCH METHODOLOGY**

**Credits: 8**

• **Course Objectives:**

The course is designed to teach the basics of *in - silico* analysis of biological data and experimental design for *invitro* assays in a problem-oriented manner. The course will introduce the process of research designs from its inception to documentation.

**Contents:**

**I. BIOINFORMATICS**

- Study of databases – primary, secondary, specialised databases
- Sequence annotations -
- Sequence alignment and phylogenetic analysis
- Protein sequence and structure analysis

**II. EXPLORING *IN VITRO* (CELL LINE BASED) ASSAYS**

**III. RESEARCH METHODOLOGY** (Bioprocess and Environment Biotechnology aspects to be explored for projects)

**References:**

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

**ASSESSMENT:**

**CIA: 80M**

**End Semester Exam: 120M**



**St. Xavier's College – Autonomous, Mumbai**

**Syllabus**

**For Semester IV Courses in M.Sc. in Biotechnology**

**(November 2019 onwards)**

## **Contents**

**Syllabus for the following courses:**

### **COURSES**

SBTS1001	ENTREPRENEURSHIP AND IPR
SBTS1001PR	ENTREPRENEURSHIP
SBTS1002PR	RESEARCH PROJECT

**SUBJECT (THEORY): BIOTECHNOLOGY**

**CLASS: MSC- SEMESTER IV**

**COURSE CODE: SBTS1001**

**TITLE: ENTREPRENEURSHIP AND IPR**

**No of Hours: 60 (inclusive of self-study)**

**Credits: 4**

**Course Objectives:**

The course aims to educate students concepts of entrepreneurship including identifying a business opportunity, gathering funds, launching a business and management principles within a business. The Intellectual Property Rights module will encompass concepts and their implications on biological research.

**UNIT 1: MANAGEMENT PRINCIPLE AND ENTREPRENEURSHIP**

**15 lectures**

- 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)
- Finance Management:
  - Understanding the role of finance in Organizations
  - Financial Statements; Taxes
  - Interest Rates
  - Break-even analysis
- Human Resource Management
  - Understanding the role of an HR Manager in Organizations
  - Interviews
  - Team building and organizational management.
- Entrepreneurship
  - The concept, meaning of entrepreneurship.
  - Functions, types of entrepreneurships
  - Stages of the entrepreneurial process.
  - The contribution of notable entrepreneurs in the field of biotechnology and applied biology. (Case studies)

**UNIT 2: BUSINESS OF BIOTECHNOLOGY**

**15 lectures**

- Project areas in biotechnology and applied biology.

- Business concept: Idea selection, brainstorming, project planning, conceptualization and feasibility report, Idea generation and Product planning, process design, IP generation, Project cost estimate, project profits
- Biotechnology companies, their care and nurturing
- Management in biotechnology
- Growth of the biotechnology industry in India
  - Rules & Regulations for the 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**

- Biotechnology and the law: objective, evolution, Commercial potential of biotech inventions, rational for IPR protection, Permissible and non-permissible Biotechnology patenting in India
- Patenting biotech inventions: objectives, concepts of novelty and concepts of inventive step, microorganisms, and moral issues in patenting biotech inventions
- Patenting issues related to Biosimilars.
- Patent reviews and Case studies
- Searching and analysing Patents

### **UNIT 4: RIGHTS, GI, AND TRADITIONAL KNOWLEDGE: CONCEPTS AND CASE STUDIES**

**15 lectures**

- Protection of geographical indications: objectives, justification, international position, multilateral treaties, national level, the Indian position
- Protection of traditional knowledge: objective, the 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.
- Plant varieties protection: objectives, justification, criteria for protection, international position, plant varieties protection in India, plant varieties protection under TRIPs
- Case studies

#### **Reference books:**

- Alexandra George (2006) Globalisation and Intellectual Property, Ashgate publishing company
- Colin Ratledge and Bjorn Kristiansen Basic Biotechnology, Cambridge University Press- 2<sup>nd</sup> Ed,2001
- David Pressman (2016) Patent It Yourself 18<sup>th</sup> edition, Nolo Publishers
- Maarten Bode, (2008) Taking traditional knowledge to the market, Orient Longman Publishers
- Poornima M Charanthmath, “Entrepreneurship Development – small Business Enterprises”, Pearson Education – 2005
- Prabudha Ganguly, (2001) Intellectual Property rights- unleashing the knowledge economy, Tata McGraw Hill Publishing Company Ltd.

- Sudeep Chaudhuri (2005), the WTO and India's Pharmaceutical industry, Oxford University Press.
- Vandana Shiva (2002), Protect or Plunder? Understanding Intellectual Property Rights, Zed Books.
- Vasant Desai, Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House

**ASSESSMENT:**

- **Continuous Internal assessment :40%**
- **End Semester Assessment: 60%**

**COURSE CODE: SBTS1001PR**

**TITLE: BUSINESS PLAN**

**Credits: 4**

**Course Objective:**

The course aims to impart knowledge and skills to prepare a robust business plan that recognises all potential opportunities and critical risks of a new biotechnology-based venture.

**Content:**

Business Proposal for a Biotechnology based Start-up

**COURSE CODE: SBTS1002PR**

**TITLE: RESEARCH PROJECT**

**Credits: 16**

**Course Objective:**

The course aims at exposing students to the intricacies of scientific research through a project undertaken by them under the guidance of academia from national research institutes.

**Content**

- Project for 5-6 months with Dissertation

**ASSESSMENT**

<b>CIA</b>	
1001PR	40M
1002 PR	160M
<b>ESE</b>	
1001PR	60M
1002PR	240 M