



ST. XAVIER'S COLLEGE – AUTONOMOUS, MUMBAI
SYLLABUS
FOR IST SEMESTER COURSES IN BIOTECHNOLOGY
(JUNE 2018 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	CELLULAR PROCESSES

PRACTICAL COURSES

MS.BTS.7.01PR	BASIC LABORATORY SKILLS
MS.BTS.7.02PR	MICROBIOLOGICAL & MOL. 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 architecture, function and purification of proteins
- To understand the higher order structure of DNA and super-coiling parameters with enzymatic manipulation
- To understand the biomolecular organization in cellular membranes

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, DENATURATION AND DEGRADATION

15 lectures

- Protein purification: Protein purification strategy,
 - Separation by Precipitation, protein quantification
 - Nonaffinity 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.
- Protein degradation – General principles, Mechanisms for Intracellular Protein Degradation, Cellular functions of protein degradation

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

UNIT 4: MEMBRANE ARCHITECTURE 15 lectures

Topics:

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

References:

- Alberts *et.al.*, Molecular Biology of the Cell, 6th edition, Garland Publishers, 2014
- Arthur M Lesk, Introduction to Protein Science Architecture, Function and Genomics, 1998, Oxford publishers
- Amit Kessel and Ner Ben Tal, Introduction to proteins, CRC Press, Taylor & Francis Group 2011,
- David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003
- Donald Voet and Judith Voet. Biochemistry 3rd Ed, John Wiley and sons, Inc publisher, 2004

- J. Berg, J. Tymoczko & L. Stryer, Biochemistry, 5thEd, W. H. Freeman & Company publisher, 2002
- Nelson and Cox, Lehninger's Principles of Biochemistry, fourth edition, Macmillan Worth Publisher, 2004
- Cooper GM, The Cell: A Molecular Approach. 2nd edition., Sunderland (MA): Sinauer Associates; 2000.
- Robert K. Scopes, Protein Purification, Springer Science, 1982,
- Philip L. R. Bonner, Protein Purification, Taylor & Francis Group, 2007

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40M

CIA I: Theory Exam (20M)

CIA II Computational- Biomolecule (20M)

ESE Pattern: 60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (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.
- 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 innate and adaptive immune effector mechanisms.

UNIT 1

IMMUNOGLOBULINS

15 lectures

- Haematopoiesis
- Immunoglobulin fine structure and super family
- Multigene organization of Ig gene, Variable region gene rearrangement and generation of antibody diversity, Class switching among constant region
- Synthesis, assembly, and secretion of Immunoglobulins

UNIT 2: MHC AND REGULATION OF IMMUNE RESPONSE

15 lectures

- 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 and its regulation

UNIT 3: EFFECTOR MOLECULES IN IMMUNE RESPONSE

15 lectures

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

UNIT 4

IMMUNE EFFECTOR MECHANISMS

15 lectures

- Innate immunity: Cells involved, signal transduction pathways, soluble molecules and membrane associated receptors (Pattern recognition, TLRs, NLRs), Phagocytosis

- The inflammatory process: role of neutrophils and other mediators in inflammation, role of NF-kb and STATs in inflammation, localised, systemic and chronic inflammation and role of anti-inflammatory agents
- Autophagy

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)

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40M

CIA I: Theory Exam (20M)

CIA II : Summary Writing/ Presentation (20M)

ESE Pattern: 60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (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 understand the cell mechanisms responsible for minimising changes in DNA.
 - To elucidate the transfer of information from genes to RNA to protein in detail
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UNIT1 GENOMES: ANATOMY AND MAPPING METHODS15 Lectures

- Human nuclear genome: features, non-coding DNA, pseudogenes, multigene family, transposons.
- Organelle genomes: mitochondria and chloroplast
- Genomes of model organisms-
a) *Saccharomyces cerevisiae* b) *Caenorhabditis elegans* c) *Arabidopsis thaliana*
d) *Drosophila melanogaster* e) *Mus musculus*
- Genetic Mapping: DNA markers for genetic mapping
- Physical Mapping: Restriction Mapping, Fluorescent in situ hybridization (FISH), Sequence tagged site (STS) mapping
- Strategies and outcomes of Human Genome Project
 - Assembly of a contiguous DNA sequence using shotgun method, clone contig method and whole genome shotgun sequence method.

UNIT2: DNA REPLICATION, REPAIR AND RECOMBINATION15 Lectures

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

UNIT 3 TRANSCRIPTION IN PROKARYOTES AND EUKARYOTES 15Lectures

- 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-tRNA

UNIT 4: Translation and Post translational modifications

15 Lectures

- Basic mechanisms of RNA to Protein conversion
- Post-translational Processing
- Processing by proteolytic cleavage
- Processing by chemical modification
- Protein Degradation

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. (6thed.) 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 (6th Ed) Garland Science Publishing., 2015

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40M

CIA I: Theory Exam (20M)

CIA II: Group Presentation/Assignment(20M)

ESE Pattern: 60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER I

COURSE CODE: MS.BTS.7.04

TITLE: CELLULAR PROCESSES

Overall learning objectives:

60 Lectures

- To understand the function of membranes with aspects of cellular signalling
 - To understand the basic concepts in neurobiology
 - To understand cell cycle and cell death process.
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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
- Liposome structure and their uses in drug targeting

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-kb signalling
- Sensory transduction in vision, olfaction and gustation

UNIT 3:

NEURONAL COMMUNICATION

15 Lectures

Topics:

- Organization of brain, Anatomy and functions of 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 its regulation 15 Lectures

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

References:

- Karl Branden and John Tooze, introduction to Protein structure, 2nded, 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 (6th Ed) Garland Science Publishing., 2015
- David E. Metzler, Biochemistry, The chemical reactions of living cells, Volume I and II., Elsevier, 2003

ASSESSMENT:

Continuous Internal Assessment (CIA) = 40M

CIA I: Theory Exam (20M)

CIA II: Scientific Essay (20M)

ESE Pattern: 60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 I

Overall Learning Objectives OF Practical Courses

- To learn basic laboratory skills and good laboratory practices
- To learn the basic microbiology and molecular biology techniques.
- To learn the basic techniques of separation, quantification, purification and characterisation of proteins.
- To study the theoretical aspects of proteins and nucleotides using computational tools.
- To learn how to plan and execute experiments and analyse the data obtained.

COURSE CODE: MS.BTS.7.01PR

TITLE: BASIC LABORATORY AND SCIENTIFIC COMMUNICATION SKILLS

1. Introduction to good laboratory practices
2. Preparation of solutions and buffers
3. Calibration of instruments: pHmeter, 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.
 - Written communication: Guide to clear writing, forms and styles of writing
 - Oral communication variants
 - Concept of Plagiarism

Recommended Books:

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

COURSE CODE: MS.BTS.7.02PR

TITLE: MICROBIOLOGY AND MOLECULAR BIOLOGY TECHNIQUES

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

References:

1. Keith Wilson and John Walker, Cambridge university Press Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010)
2. Rodney Boyer, Biochemistry Laboratory (2nd Ed, 2012), Pearson's Publication
3. Sheppler J and Cassin P, Biotechnology explorations (2000), ASM Press

COURSE CODE: MS.BTS.7.03PR

TITLE: BIOCHEMISTRY

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 (7th Ed, 2010)
Keith Wilson and John Walker, Cambridge university Press
2. Biochemistry Laboratory (2nd Ed, 2012) Rodney Boyer, Pearson's Publication

COURSE CODE: MS.BTS.7.04PR

TITLE: COMPUTATIONAL TOOLS IN BIOLOGY

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

References:

1. Online resources

Assessment:

CIA: 80M (Continuous assessment based on lab skills and problem solving)

ESE: 120M

Experiment based- 70 M

Viva/Quiz/ Problem solving- 50M



St. Xavier's College – Autonomous

Mumbai

Syllabus

For IInd Semester Courses in M.Sc in Biotechnology

(June 2018 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: 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
- To understand the role of plant cell culture in metabolic engineering

Unit 1 Carbohydrate and Lipid metabolism 15 lectures

- Carbohydrate metabolism: HMP, Uronic acid pathway
- Glycogen metabolism: Glycogenesis and Glycogenolysis, Glycogen storage diseases
- Lipid metabolism: synthesis of essential fatty acids and its biological significance.
- Lipoprotein Metabolism and role of Lipoproteins in diseases.

Unit 2 Protein and Nucleic Acid Metabolism 15 lectures

- Metabolism of amino acids
 - Biosynthesis of phenylalanine, tyrosine, threonine and methionine
 - Metabolic breakdown of amino acids and disorders of amino acid metabolism
- Metabolism of nucleotide
 - Biosynthesis and degradation of purines and pyrimidines
- Regulation of metabolism and disorders of Nucleic acid metabolism

Unit 3 Plant metabolism

15 lectures

- C-3 cycle and C-4 cycles
- CAM, glyoxylate pathway
- Photosynthetic formation of hydrogen
- Nitrogen fixation and role of nitrogenase

Unit 4 Applications of cell culture in metabolic engineering 15 lectures

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

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)
- 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)
- 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. (30th 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 = 40Marks

CIA I: Theory Exam (20M)

CIA II: Quiz (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER II

COURSE CODE: MS.BTS.8.02

TITLE: CLINICAL IMMUNOLOGY

Overall learning objectives:

60 lectures

- To understand the response of the human body towards microbes, allergens, grafts, tumours and infections.
 - To understand the immune deficiencies and diseases
 - To study the various experimental systems and techniques involved in understanding Immune biology
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Unit 1 Hypersensitivity, Autoimmunity and Immunodeficiencies 15 lectures

- Hypersensitivity: Type I, II, III, IV hypersensitivity
- Autoimmunity: Organ specific, systemic, mechanism, treatment
- Primary and secondary immunodeficiency

Unit 2 Immuneresponses to transplants and tumours 15 lectures

- Transplantation immunology: Basis of Graft rejection, clinical manifestation of graft rejection, Immune tolerance, Immunosuppressive therapy and clinical transplantation
- Oncogenes and cancer induction, tumours of immune system
- Tumour antigens and tumour evasion of immune system
- Cancer immunotherapy

Unit 3 Immune response to infectious agents

15 lectures

- Bacterial infections
- Viral infections
- Parasitic infections
- Fungal infections

Unit 4 Experimental systems and advances in Immunology 15 lectures

- Animal models: Inbred strains, Knock out/Knock in, transgenic models, models for immune diseases
- Cell line models for immunology studies
- Ag-Ab interaction assays for understanding immune biology, diagnostics and therapeutics (ELISA, Flow cytometry, SPR, RIA, Immunoprecipitation, Immunofluorescence- cytochemistry and histochemistry)
- Antibody engineering (inclusive of hybridoma technology, display libraries and examples)

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)
- Gordan Reeve and Ian Todd, Immunology, 4thEd. Blackwell Publishing House
- Todd, Ian & Spickett, Gavin: Immunology. (5th ed.) Malden. Blackwell Publishing, Inc, 2005. 1-4051-4560-9--(616.079Tod/Spi)
- Henry Y. Wang, Tadayuki Imanaka (1995). Antibody Expression and Engineering, Vol 604, American Chemical Society
- Tizard, Ian R.: Immunology: an introduction. (4th Ed. Indian reprint) Singapore. Thomson Asia Pte Ltd., 1995(2004). 981-243-516-6--(616.079TIZ)
- Male, David; Brostoff, Jonathan; Roth, David B. & Roitt, Ivan M.: Immunology. (8th ed.) Amsterdam. Elsevier Ltd., 2013. 978-0-7020-4548-6--(616.079Roi)
- Luttmann, Werner, Bratke, Kai, Kupper, Michael & Myrtek, Daniel: Immunology. Burlington. Academic Press, 2006. 978-0-12-088544-2--(616.079Lut)
- William R. Strohl and Lila M. Strohl (2012). Therapeutic antibodyengineering, Woodhead Publishing Limited.

ASSESSMENT:

Continuous Internal Assessment: 40M

CIA I: Theory Exam (20M)

CIA II: Review Article (WrittenAssignment) (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER II

COURSE CODE: MS.BTS.8.03

TITLE: MOLECULAR AND CELLULAR BIOTECHNOLOGY

Overall learning objectives:

60 lectures

- 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
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UNIT 1

Regulation of Genome Activity

15 lectures

- Genome rearrangements, Gene silencing by modification of histones and DNA
- Regulation of Genome Activity during Development: Vulva development in *Caenorhabditis elegans* and Development in *Drosophila melanogaster*
- Genome editing techniques: RNAi, Nucleases (Zn finger nucleases, Transcription associated nucleases, CRISPR- Cas9)

UNIT 2:

DNA VECTORS

15 lectures

- Expression vectors for the following: for maximizing protein synthesis, facilitate protein purification, promote protein solubilisation, promote protein export
- Vectors for making RNA probes: BACs and PACs
- Cloning in Yeast-Plasmid vectors, expression of cloned genes, over expression of proteins, yeast two hybrid system
- Vectors in Animal cells-plasmid vectors, selectable markers, viral vectors-Adeno, retro, lentivirus

Unit 3

Application of rDNA technology

15 lectures

- Plant engineering to overcome abiotic and biotic stress like insect resistance, virus resistance, herbicide resistance, salt and drought stress.
- Plant engineering for modification of nutrient content: Amino Acids, Lipids, Vitamins, Iron
- Synthesis of commercial products - Restriction Endonucleases

UNIT 4

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, histiotypic culture and organotypic culture
- Cytotoxicity

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)
- Voet, Donald & Voet, Judith G.: Biochemistry. (4th ed.) Hoboken. John Wiley & Sons (Asia) Pte. Ltd., 2011. 1-1180-25024--(574.192Voe/Voe)
- 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)
- Griffiths, Anthony J.F., Wissler, 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)
- John M Davis , Animal Cell Culture: Essential Methods , , John Wiley & Sons
- 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)
- 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)
- 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)
- Sambrook J, Russell., Molecular cloning, Vol I, II , III, CSHL Press
- 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.: Genomes 3. New York. Garland Science Publishing, 2007. 0-8153-4138-5--(575.1Bro)
- 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

ASSESSMENT:

Continuous Internal Assessment: 40M

CIA I: Theory Exam (20M)

CIA II: ReviewWriting (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER II

COURSE CODE: MS.BTS.8.04

TITLE: ADVANCED ANALYTICAL TECHNIQUES

Overall learning objectives:

60 L

- To understand the principles, working mechanism, data analysis and applications of various analytical techniques used to study Biomolecules.
 - To understand the principle and application of gene amplification
-

Unit 1 Spectroscopy 15 lectures

Basic principles, instrumentation and applications of the following:

- Fluorescence spectroscopy
- ORD, CD spectroscopy
- NMR and ESR

Unit 2 Advances in Microscopy and X-Ray Crystallography 15 lectures

- Advanced Microscopy: Different versions of advanced microscopy, electron microscopy and confocal microscopy
- X-Ray Crystallography : Principles, instrumentation and application

Unit 3 Gene amplification technique 15 lectures

- PCR and its types
 - Nested, ARMS, Inverse, SSCP, Real Time, Quantitative PCR and Multiplex PCR
- Molecular diagnostics
 - Bacterial infections, Fungal infections, Viral infections and Parasitic infections

Unit 4 Advanced Analytical Techniques 15 lectures

- 2-D PAGE
- Advances in Chromatography
- Mass spectrometry: MALDI-TOF-MS/MS
- Biochips (DNA, Protein and Biosensors)

References:

- Bartlett & Stirling , PCR protocols, 2nded ., 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 (40M)

CIA I: Theory Exam (20M)

CIA II: Primary paper presentation (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 II

Overall Learning Objectives:

- To learn the basic techniques for understanding metabolism, recombinant DNA technology, basic tools used in Immunology and basic techniques in animal cell culture
 - To plan, execute experiments and analyse the data obtained.
-

COURSE CODE: MS.BTS.8.01PR

TITLE: BIOCHEMICAL TECHNIQUES AND ASSAYS

- Determination of acid value of lipids
- Determination of phosphorus from serum
- Estimation of cholesterol from the serum sample
- Estimation of Urea from serum or urine
- Estimation of Creatinine from serum or urine
- Isolation of chloroplast by sucrose gradient centrifugation
- Measurement of proton uptake by DCPIP
- Separation of photosynthetic pigments by chromatography
- Measurement of chlorophyll content
- Vitamin B12 bioassay
- Enzymatic assay (Invertase)
- Study of phytochemicals (extraction and characterisation)

References:

- 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)

SUBJECT (PRACTICALS): BIOTECHNOLOGY

CLASS: MSC- SEMESTER II

COURSE CODE: MS.BTS.8.02PR

TITLE: MOLECULAR BIOLOGY

- Isolation of DNA from yeast
- Isolation of RNA from yeast/ *E.coli*
- Creation of genomic library: Isolation of genomic DNA and Plasmid DNA , Restriction Digestion, Ligation and Transformation
- Expression of recombinant proteins
- PCR amplification of 16srRNA
- RFLP analysis
- Preparation of glycerol stocks

References:

- 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

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

References:

- Kuby, Janis: Immunology. (7th ed.) New York. W.H. Freeman and Company, 2013. 978-1-4641-3784-6--(616.079Kub)
- 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)

SUBJECT (PRACTICALS): BIOTECHNOLOGY

CLASS: MSC- SEMESTER II

COURSE CODE: MS.BTS.8.04PR

TITLE: ANALYTICAL TECHNIQUES DATA INTERPRETATION

- Instrumentation and Data interpretation of the following techniques
 - HPLC and Gas chromatography
 - 2D electrophoresis
 - Mass spectrometry
- Study of metabolic pathway databases eg: KEGG
- Primer designing, Primer validation and study of PCR condition
- Study of properties of nucleotide sequence: nucleotide count, translation, reverse translation
- Study of in silico restriction digestion
- Study of vectors
- Gene finding

References:

- 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 (Continuous assessment based on lab skills and problem solving)

End Semester Exam: 120M

Experiment based- 70 M

Viva/Quiz/ Problem solving- 50M



St. Xavier's College – Autonomous

Mumbai

Syllabus

For 3rd 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

SUBJECT (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER III

COURSE CODE: MS.BTS.9.01

TITLE:BIostatistics AND BIOinformatics

Overall Learning Objective:

60 lectures

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

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 mean, paired and cochran's)
- χ^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 (Estimationetc)
- The standard Normal distribution
- Hypothesis Testing: step, errors
- Non-parametric tests: Sign, Wilcoxon and Mann- Whitney test

UNIT 3 DATABASES AND SEQUENCE ALIGNMENT

15 lectures

- Introduction to Bioinformatics: Goal, Scope, application (outline), new themes
 - Study of biological databases
 - Concept of databases
 - Biological data and databases, classificationExamples of databases (sequence, structure, classification, genome, microarray, secondary databases)
 - Submission of sequences, biological data retrieval and study of data formats
 - Pitfalls of biological databases and annotations of biological data.
 - Sequence alignment:
 - Pairwise sequence alignment: sequence homology, similarity and identity,methods, scoring matrices, BLAST: types , method , parameters
-

- Multiple sequence alignment: scoring function goal and application, principle and methods, tools used
- Editing MSA: Jalview, Sequence logo
- Phylogenetic analysis and importance:
 - Phylogenetics basics: Molecular Evolution and Molecular Phylogenetics, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation
 - Phylogenetic Tree Construction Methods and Programs: distance based and character based methods

UNIT 4 PROTEIN STRUCTURE VISUALIZATION, PREDICTION, GENES AND GENOME ANALYSIS **15 lectures**

- Study of proteins
 - Protein structure prediction: secondary structure and tertiary structure (Homology modelling)
 - Protein structure comparison, visualization and significance
 - Bioinformatics basis of protein structural classification: CATH
- DNA/ gene sequence analysis:
 - Gene prediction: Categories of Gene Prediction Programs, Gene Prediction in Prokaryotes and eukaryotes
 - DNA motifs and its significance
- Genomics and proteomics
 - Genome mapping, assembly, and comparison
 - Functional genomics: Microarrays and SAGE
 - Next-generation sequencing (NGS)
 - Proteomics: Technology of Protein Expression Analysis, iTraq

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. 2nd edition, Cold Spring Harbor Laboratory Press, New York.
- Jonathan Pevsner (2009) Bioinformatics and Functional Genomics. 2nd edition, John Wiley and Sons, New Jersey.
- Teresa K. Attwood and D. J. Parry Smith (1999) Introduction to Bioinformatics. 1st 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. 2nd edition, A John Wiley & Sons, Inc., Publication
- Arthur M. Lesk (2005) Introduction to Bioinformatics, 2nd edition Oxford University Press
- JinXiong(2006), Essential Bioinformatics, 1st edition, Cambridge university press,

ASSESSMENT:

Continuous Internal assessment (40M)

CIA I: Theory Exam (20M)

CIA II: Problem Solving (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER III

COURSE CODE: MS.BTS.9.02

TITLE:APPLICATIONS OF BIOTECHNOLOGY

Overall learning objective:

60 lectures

- 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 & *IN VITRO* FERTILIZATION 15 lectures

- Embryonic development stages [fertilisation, post fertilisation, Implantation]
- Establishment of germ layers and their fate
- Immunology of pregnancy
- IVF Technology

UNIT 2 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, Bio mimetic materials
- Applications of tissue engineering

UNIT 3 BIOPHARMACEUTICALS 15 lectures

- Scale up in cell culture (types of bioreactors for suspension and monolayer cultures and process control)
- Therapeutic peptides/ Biosimilars- production and dynamics- Production methodology, Pharmacokinetics and Pharmacodynamics
 - Insulin
 - Tissue plasminogen activator
 - Interferon – alpha
 - Erythropoietin
 - Vaccines
 - Monoclonal antibodies

UNIT 4: MOLECULAR FARMING AND PROTEIN ENGINEERING 15 lectures

- 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:

- 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 (40M)

CIA I: Theory Exam (20M)

CIA II: Review Writing (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER III

COURSE CODE: MS.BTS.9.03

TITLE:BIOPROCESS TECHNOLOGY

Overall Learning Objective:

60 lectures

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

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 fermentor design and product formation
- Solid state fermentation
- Processes using recombinant organisms: hosts, vectors, genetic instability.

UNIT 2 PROCESS DYNAMICS

15 lectures

- Gas exchange and mass transfer: O₂ transfer, critical oxygen concentration, determining the oxygen uptake rate.
- Heat transfer
- Sterilization – processes, thermal death curve, *in situ* sterilization

UNIT 3DOWNSTREAM PROCESSING

15 lectures

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

UNIT 4 INDUSTRIAL PRODUCTS

15 lectures

- Polysaccharides/ biopolymers/micro polymers- Xanthan gum, Dextran
- Enzymes – proteases, amylases, pectinases, lipases
- Nutraceuticals – Probiotics and prebiotics
- Antibiotics – erythromycin
- Vitamin B₁₂
- Amino acids and alcohols

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. 2nd edition, Butterworth-Heinemann
- Wulf Crueger and Anneliese Crueger (1990) Biotechnology: A Textbook of Industrial Microbiology. Panima Publishers. New Delhi

ASSESSMENT:

Continuous Internal assessment (40M)

CIA I: Theory Exam (20M)

CIA II: Essay Writing (20M)

SUBJECT (THEORY): BIOTECHNOLOGY

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER III

COURSE CODE: MS.BTS.9.04

TITLE: ENVIRONMENTAL BIOTECHNOLOGY

Overall Learning Objective

60 lectures

- 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
-

UNIT 1:ENVIRONMENTAL POLLUTION AND MANAGEMENT

15 lectures

- Concept of Environmental Pollution; Origin of pollution; Classification and nature of Environmental Pollutants; Bioremediation, Biotransformation and Biodegradation- (specific case study)
- Sources of heavy metal pollution; Microbial interactions, Microbial metal resistance; Microbial transformation; Accumulation and concentration of metals; Biosorption - biotechnology and heavy metal pollution, phytoremediation – case studies
- Solid waste management of municipal, biomedical waste and E waste management
- Xenobiotics; Persistence and biomagnification of xenobiotic molecules; Microbial interactions with xenobiotics.
- 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.

UNIT 2: MARINE POLLUTION AND BIODETERIORATION 15 lectures

- Types of marine and mangrove environment - Physical, Chemical and Biological aspects and their interaction with marine life;Threats to the Marine and mangrove Environment: Marine pollution-major pollutants and Biological indicators (eg: Marine microbes, algae and crustaceans) and accumulators:
- Oil pollution: Sources, composition and its fate in marine habitats. Treatment options available, case studies
- Thermal and radioactive pollution: sources, effects and remedial measures.
- Solid dumping, mining and dredging operations: their effects on marine ecosystem.
- Biofouling and biodeterioration: Agents and protection methods.

- Effect of marine pollution on environment and human health and Role of biotechnology in marine pollution control.

UNIT 3:ENVIRONMENTAL MONITORING AND MANAGEMENT15 lectures

- 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.
- Environmental management: problems and need, Environmental management Plan
- Environmental impact assessment and ISO 14000
- Concept of environmental sustainability
 - Biotechnology for management of resources: Role of environmental biotechnology in management of resources;
 - Reclamation of wasteland; Biomass production
 - Biofuel production,Development of environmentally friendly processes such as integrated waste management, bioplastics

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

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 , 1st edition , Oxford University Press
- Alexander N. Glazer and Hiroshi Nikaido (2010) Microbial Biotechnology, 2nd edition, Cambridge University press.
- Bernard R. Glick, Jack J. Pasternak, Cheryl L.Patten. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
- Biosafety in Microbiology and biomedical laboratories, 5th 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 Intersciences Publishers
- <http://dbtbiosafety.nic.in>
- <http://igmoris.nic.in>
- <http://www.dbtindia.nic.in/regulations/>
- Humberto Vega-Mercado, Michael Dekleva, RizwanSharnez, and Luis Baez, May 2003, HACCP: A Process Validation Tool for Ensuring Quality of Biotech and Pharmaceutical Products, *Bioprocess technology*
- InduShekhar 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

ASSESSMENT:

Continuous Internal assessment (40M)

CIA I: Theory Exam (20M)

CIA II: Field Study Report Presentation (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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

Overall Learning Objectives:

- To learn the basics of *in - silico* analysis of biological data
- To understand experimental design for *invitro* 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

TITLE: BIOINFORMATICS

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

COURSE CODE: MS. BTS. 9.02PR

TITLE: ANIMAL CELL CULTURE

- Cytotoxicity testing using MTT and SRB

COURSE CODE: MS. BTS.9.03PR

TITLE: BIOPROCESS TECHNOLOGY

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

COURSE CODE: MS. BTS.9.04PR

TITLE: RESEARCH METHODOLOGY

- Research approaches, Research Process and Criteria for Good Research
- Research problem: definition, techniques involved, illustration
- Research design: meaning, Important Concepts and basic Principles of Experimental Designs, Research ethics
- Internal Project

References:

- C.R. Kothari, Research methodology: methods and techniques, 2nd edition, New Age International Publishers, 2004
- David Mount (2004) Bioinformatics: Sequence and Genome Analysis. 2nd edition, Cold Spring Harbor Laboratory Press, New York.
- HansmauderSchmauder, 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, 5th / 6th Ed

ASSESSMENT:

CIA: 80M (Continuous assessment based on lab skills and problem solving)

End Semester Exam: 120M

Experimentbased/ Quiz/ Problem solving - 60 M

Viva/ Report/ Presentation- 60M



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

Syllabus

**For IVth Semester Courses in M.Sc in Biotechnology
(June2017 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

SUBJECT (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER IV

COURSE CODE: MS.BTS.10.01

TITLE: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
-

UNIT 1

DRUG DEVELOPMENT

15 lectures

- Drug discovery
 - Steps involved in drug discovery, Production and characterisation, 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

CLINICAL RESEARCH

15 lectures

- Introduction, Good clinical practice guidelines, Ethical aspects of clinical research
- Clinical research methodologies and management, Regulatory requirements

UNIT 3 REGULATORY AFFAIRS AND PHARMACOVIGILANCE 15 lectures

- Introduction to Adverse Events and Classifications
- Scope of Drug Safety Problems
 - Introduction to Pharmacovigilance: History and development of pharmacovigilance
 - Importance of safety monitoring / Why pharmacovigilance
- National and international scenario : WHO international drug monitoring programme
- Pharmacovigilance methods : Passive surveillance, Active surveillance, Comparative observational studies – Cross sectional study, case control study and cohort study
- Adverse drug reaction reporting : Spontaneous reporting system and Reporting to regulatory authorities
- Drug Safety: role of FDA and ICH
- Investigational New Drug Applications: Documents and Communication (Review period and approval period)

UNIT 4 NANOTECHNOLOGY IN MEDICINE 15 lectures

- Introduction to nanotechnology:nanotechnology and bio-nanotechnology,important nano-particles / materials, bionanorobots/molecular motors nano motors and their uses
- Synthesis and characterization of nanoparticles:Common Strategies with examples
- Applications of nanotechnology:
 - Medical nanotechnology , Nano-diagnostics : Nano particles for the detection and treatment of cancer, Nano arrays for molecular diagnostics , Nanoparticles for Molecular Diagnostics, nanobarcode
 - Nano pharmaceuticals : Nanobiotechnology for drug discovery and drug delivery
 - Role of nanotechnology in biological therapy , nano devices ain medicine and surgery

References:

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

ASSESSMENT:

Continuous Internal assessment (40M)

CIA I: Theory Exam/ Group activity (20M)

CIA II: Essay Writing (20M)

End Semester Exam Pattern:60 Marks:

No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 (THEORY): BIOTECHNOLOGY

CLASS: MSC- SEMESTER IV

COURSE CODE: MS.BTS.10.02

TITLE:ENTREPRENEURSHIP AND IPR

Overall LearningObjective:

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 ENTREPRENEURSHIP15 lectures

- Marketing Management:
 - Understanding the role of marketing in Organizations
 - Marketing Research and its importance
 - Understanding the Micro Environment (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 a HR Manager in Organizations
 - Interviews
 - Team building and organizational management
- Entrepreneurship
 - Concept, meaning of entrepreneurship
 - Functions, types of entrepreneurship
 - Stages of entrepreneurial process.
 - Contribution of notable entrepreneurs in the field of biotechnology and applied biology. (Case studies)

UNIT 2 BUSINESS OF BIOTECHNOLOGY15 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 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

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

**UNIT 4 GEOGRAPHICAL INDICATIONS AND TRADITIONAL KNOWLEDGE:
CONCEPTS AND CASE STUDIES 15 lectures**

- Protection of geographical indications: objectives, justification, international position, multilateral treaties, national level, Indian position
- Protection of traditional knowledge: objective, concept of traditional knowledge, holders, issue concerning, bio-prospecting and bio-piracy, alternative ways, protectibility, 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
- Case study related to basmati rice, erythropoietin, t-PA, glivec
- Permissible and non-permissible biotech patenting in India

Reference books:

- Alexandra George (2006) Globalisation and Intellectual Property, Ashgate publishing company
- Colin Ratledge and Bjorn Kristiansen Basic Biotechnology, Cambridge University Press- 2nd Ed, 2001
- David Pressman (2016) Patent It Yourself 18th 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.
- S S Khanka , Entrepreneurship Development” S Chand
- 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 (40M)

CIA I: Theory Exam (20M) CIA II: Market survey – Biotech/ pharma related (20M)

End Semester Exam Pattern:60 Marks:		
No. of Units	No. of Questions	Marks per Question
4	4 (1 from each Unit)	15 marks per question.
100 Marks:		
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 IV

Overall Learning Objective:

- To train the students in different aspects of IPR and Entrepreneurship

COURSE CODE: MS. BTS. 10.01PR

TITLE: IPR

- Searching patents and analysing patents

COURSE CODE: MS. BTS. 10.02 PR

TITLE: ENTREPRENEURSHIP

- Business Proposal for a Biotechnology based Start up

COURSE CODE: MS. BTS. 10PR

TITLE: RESEARCH PROJECT

- Project for 5 months with Dissertation

ASSESSMENT

CIA	
4.01 PR + 4.02 PR	40M
4PR	120M
ESE	
4.01 PR + 4.02 PR	60M
4PR	180M