SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: M.Sc.

Subject: BIOTECHNOLOGY

Academic Year: 2018 – 2019

M.Sc Part I

Credit Based Semester and Grading Syllabi approved by Board of Studies in Biotechnology to be brought into effect from June 2018.

PREAMBLE

Biotechnology, broadly defined, includes any technique that uses living organisms, or parts of such organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific use. The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on.

Biotechnology is the science of today and tomorrow. It has applications in all major service sectors. i.e. health, agriculture, industry, environment etc. Biotechnology as an application science has taken firm footing in many countries, abroad where a number of transgenic crops, genetically modified food and recombinant therapeutic molecules for human and animal health are available in the market. Biotechnology as a science of service to human society is yet to make inroads in India

With the advent of World Wide Web in the early nineties and its subsequent growth, the latest research trends have become accessible from drawing rooms across the globe. This acted as a positive feedback mechanism in increasing the pace of research in all fields including Chemical Engineering and Bio-technology. This was the motivation for an in depth analysis of what is actually required for today's technology. It is also important to take advantage of the freely available software to enhance the quality and quantity of material that can be covered in the class room.

This restructured syllabus is therefore intended to combine the principles of physical, chemical and biological sciences along with developing advanced technology. The undergraduate curricula is prepared to impart primarily basic knowledge of the respective subject from all possible aspects. In addition, students will be trained to apply this knowledge particularly in day-to-day applications of biotechnology and hence get a flavor of research

Semester I				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/week**
SIPSBT11	Theory	**Biochemistry I**	4	4
SIPSBT12	Theory	**Immunology I**	4	4
SIPSBT13	Theory	**Molecular Biology I**	4	4
SIPSBT14	Theory	**Biochemical and Biophysical techniques**	4	4
SIPSBTP11	Practicals	**Biochemistry**	4	4
SIPSBTP12	Practicals	**Immunology I**	4	4
SIPSBTP13	Practicals	**Molecular Biology**	4	4
SIPSBTP14	Practicals	**Biochemical and Biophysical techniques**	4	4
Semester II				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/week**
SIPSBT21	Theory	**Biochemistry II**	4	4
SIPSBT22	Theory	**Immunology II**	4	4
SIPSBT23	Theory	**Molecular Biology II**	4	4
SIPSBT24	Theory	**Bioprocess technology**	4	4
SIPSBTP21	Practicals	**Biochemistry II**	4	4
SIPSBTP22	Practicals	**Immunology II**	4	4
SIPSBTP23	Practicals	**Molecular Biology II**	4	4
SIPSBTP24	Practicals	**Bioprocess technology**	4	4

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT11	**Biochemistry**		
Course Objectives	To understand: • the structure and interaction of proteins • Complex carbohydrates • Membrane transport and dynamics • Mode of action of various narcotic drugs and the associated toxicity		
Unit I **Proteins**	Protein structure: Protein Tertiary and Quaternary Structures – Protein Denaturation and Folding ; Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins – Complementary Interactions between Proteins and Ligands: Immunoglobulins Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors; Protein purification	**4**	**15**
Unit II **Carbohydrates**	Glycosaminoglycans- Heparin, Chondroitin sulphate, Hyaluronic acid Glycoproteins & Glycolipids, Acidic sugars – ascorbic, glucuronic acid, photosynthetic carbohydrate synthesis, photorespiration, C4 and CAM pathways, Synthesis of cell wall polysaccharides- Cellulose & Chitin, Integration of carbohydrate metabolism in the plant cell		**15**
Unit III **Membrane Dynamics**	Membrane dynamics and transport of solutes across the membrane; States of bilayer lipids, Transbilayer Movement of Lipids, Flip-flop diffusion. Measurement of lateral diffusion rates of lipids by fluorescence recovery after photobleaching (FRAP). Hop diffusion of individual lipid molecules; Calveolins and cadherins; Membrane Fusion; Transporter classification system channel (Na+ channel of neurons) and ligand (acetyl choline) mediated transport with examples. ABC transporters and Ionophores, Diseases associated with Defective Ion Channels		**15**
Unit IV **Neurochemistry & Toxicology**	Neurochemistry: Opoid peptides, Prostaglandins, Psychotic and narcotic drugs and their mode of action; Special senses- taste, vision, odor and hearing. Toxicology: Definitions; General principles; Systemic Toxicology; Carcinogenicity; Mutagenicity; Teratogenicity; Reproductive Toxicity; Local Toxicity; Genotoxicity; Animal Toxicity requirements		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT12	**Immunology I**		
Course objectives	To understand: • The properties and mechanism of cytokines • The generation of antibody diversity and engineering • Lymphocyte development and maturation • Immune mechanism during transplantation		
Unit I **Cytokines and Antibody Diversity**	Cytokines: Properties, Classification, Receptors, Signalling, Cytokine secretion by TH1 and TH2 , Cytokine related diseases, Cytokine expression Generation of Antibody Diversity: Germ line and Somatic theory, Dreyer and Bennett model, Multigene organization of Ig gene, Variable gene rearrangements, Generation of antibody diversity, Synthesis, assembly, and secretion of immunoglobulins. Antibody engineering, Chimeric antibodies	**4**	**15**
Unit II **Lymphocyte Development and maturation**	T cell Development: Early thymocyte development, positive and negative selection, Differentiation, maturation, Apoptosis B cell development: development in Bone marrow, B cell lineages (B1 and B2), T dependent and independent responses, Negative regulation of B cells. Comparison of B and T cell development		**15**
Unit III **Cytotoxic responses and Transplantation immunology**	Effector responses of T cells, NK cells, ADCC Transplantation: Basis of Graft rejection, clinical manifestation of graft rejection; immunosuppressive therapy; immune tolerance; clinical transplantation		**15**
Unit IV **Introduction to Psychoneuro-immunology**	Connections of CNS to immune system and *vice versa*, Psychological modulation of immunity, stress and immunity, implication for diseases, functional significance – inflammation and acute phase response, role of glucocorticoids, stress response, energy demand and balance.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT13	**Molecular Biology**		
Course Objectives	To acquaint the students with human genome and gene evolution as well as various mapping and sequencing techniques To have a firm foundation on mechanism of transcription, RNA processing as well as the regulation of gene expression		
Unit I Gene evolution and The human genome	The content of human nuclear genome, tandemly repeated DNA, interspersed genome-wide repeats. Human mitochondrial genome. Genome evolution-Acquisition of New Genes (gene duplication, from other species, transposable elements), Non-coding DNA, Mobile genetic elements, Transposable elements in bacteria and eukaryotes	**4**	**15**
Unit II Mapping techniques	Genetic Mapping: DNA markers for genetic mapping, Physical Mapping: Restriction Mapping, Fluorescent in situ hybridization (FISH), Sequence tagged site (STS) mapping, Next Gen sequencing, Human genome project		**15**
Unit III Transcription	Transcription in prokaryotes and eukaryotes, Types of RNA polymerases, Transcription in cell organelles, RNA processing in eukaryotes, Synthesis of eukaryotic mRNAs by RNA polymerase II, Intron splicing. 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. Processing of Pre-RNA. Degradation of mRNAs		**15**
Unit IV Regulation of gene expression	DNA-Protein interactions during Transcription Initiation, Activators, Enhancers, Insulators, DNA binding domain, Regulation of Transcription: Recruitment of protein complexes to genes by eukaryotic activators, Signal integration and Combinatorial control, Transcriptional repressors, Signal transduction and control of transcriptional regulators, Eukaryotic Gene Regulation at steps after transcription initiation		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT14	**Biochemical and Biophysical techniques**		
Course Objectives	To acquaint the students with various techniques of cell imaging and spectroscopic methods To introduce them to purification and analytical techniques in molecular biology		
Unit I **Microscopic techniques**	Confocal microscopy, Scanning Probe microscope, AFM, cryotomy scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy, single cell imaging. Environmental SEM, and its advantages	**4**	**15**
Unit II **Spectroscopy**	Introduction and principle of: fluorescence spectroscopy, Light scattering spectroscopy, Luminometry, circular dichroism, NMR and ESR spectroscopy , Molecular structure determination using X-ray diffraction, X ray crystallography and NMR, Molecular analysis using light scattering, IR, Atomic absorption Spectroscopy		**15**
Unit III **Instrumentation**	Introduction, principle and analysis using HPTLC, Capillary electrophoresis, Gel free electrophoresis, Types of PCR, mass spectrometry and LC-MS, GCMS		**15**
Unit IV **Cell imaging techniques**	Cell imaging Techniques- In vitro and In vivo; Immunoelectron microscopy; In vivo cell tracking techniques; Reporter Assays, In–situ gene expression techniques; Microarrays, Flow cytometry		**15**

PRACTICALS

SIPSBTP11 Biochemistry:

1. Isolation of starch from potato and its estimation by Anthrone method.
2. Estimation of Protein by Bradford's method.
3. The isolation and assay of glycogen from liver.
4. Purification of protein by ammonium sulphate fractionation, dialyze and separate using PAGE.
5. Study of protein complexes using SDS-PAGE and visualization using silver staining.
6. Preparation of RBC ghost membrane and determination of ATPase activity
7. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum.
8. Chemistry of thinking:
    a. Study of different regions of brain using models.
    b. Stroop test and blind spot test.
    c. Color blindness and optical illusions

SIPSBTP12 Immunology:

1. DOT-ELISA
2. Antigen antibody reactions: one of each type: precipitation (VDRL setup in tube or gels), WIDAL.
3. Quantification of antigen using Single Radial Immuno-Diffusion.
4. Immuno-diffusion and immune-electrophoresis (electrophoresis of serum and then reaction with anti-whole human serum antiserum).
5. Serum electrophoresis
6. Western Blotting

SIPSBTP13 Molecular Biology:

1. Extraction of genomic DNA from bacteria and blood
2. Perform transformation of bacteria.
3. Expression of recombinant protein
4. Restriction digestion
5. Ligation
6. Induction of β-Galactosidase in of *E. coli* (and effect of inducers)

SIPSBTP14 : Biochemical and Biophysical techniques

1. Polymerase Chain Reaction
2. Extraction of pigments from biological sources – plants and/or microorganisms and study of their absorption spectrum in visible light.
3. Separation of pigments using column chromatography
4. Viscosity of Proteins
5. Demonstration and interpretation of NMR, HPLC, GC readouts.
6. Separation of sugars using TLC.
7. Use of affinity chromatography for purification of antibodies from serum.

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT21	**Biochemistry II**		
Course Objectives	To familiarize the students with metabolomics and enzymology		
Unit I **Lipid and nucleic acid metabolism**	Lipid metabolism: Phospholipids, Cerebrosides and Gangliosides; triacyl glycerols and its biosynthesis; lipoprotein and lipid transfer; Lipoproteins structure, function, disorders and dysfunction in Alzheimer's disease; Steroid hormones, lipid storage diseases Biosynthesis and degradation of purines and pyrimidines with regulation, disorders of Nucleic acid metabolism	**4**	**15**
Unit II **Enzyme kinetics**	Introduction: Classification, kinetics, Bisubstrate reaction, stable state kinetics, enzyme inhibitions, examples of enzymatic reaction-chymotrypsin, induced fit hypothesis, Catalytic antibodies, Regulatory enzymes and their mode of action and covalent modification of enymes		**15**
Unit III **Protein Metabolism**	Biosynthesis of essential amino acids. Metabolic breakdown of amino acids leading to Krebs cycle intermediate. Disorders of amino acid metabolism		**15**
Unit IV **Metabolism: integration and regulation**	Organ specialization, Metabolic homeostasis, Hormonal control of fuel metabolism		

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT22	**Immune System and Disease**		
Course Objectives	To understand the diseases associated with immune system and their associated mechanisms To acquaint the students with designing of vaccines and its QA/QC		
Unit I **Hypersensitivity and Autoimmunity**	Hypersensitivity: Classification and types Autoimmunity: Tolerance (Central and peripheral), Organ Specific and Systemic autoimmune diseases, Proposed mechanism for induction of autoimmunity, Treatment of Autoimmune disease	**4**	**15**
Unit II **Cancer Immunology**	Cancer: Terminology, Malignant transformation of cells, Cancer induction, Tumor Antigens., tumor evasion, Cancer immunotherapy. Cancer Vaccine		**15**
Unit III **Immuno-deficiencies and Immune response to infectious diseases**	Immunodeficiencies: Primary & Secondary Viral infections, Bacterial infections, Parasitic diseases, Fungal diseases		**15**
Unit IV **Vaccines**	Designing vaccines for active immunizations, Conjugate, Recombinant Vector Vaccines, Genetic Immunization; Delivery of vaccines; Bacteria as antigen delivery system; Quality control (in-process and final product control) and quality assurance of sterile products- Bioburden, test of sterility, parametric release, pyrogen testing, seed lot system.		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT23	**Molecular Biology**		
Course Objectives	The objective of this course is to enable the students to understand the nuances of translation, regulation of gene expression and applications of model organisms		
Unit I **Translation**	Translation in Prokaryotes and Eukaryotes, Post-translational Processing: Processing by proteolytic cleavage, Processing by chemical modification, Inteins splicing, Protein Degradation.	**4**	**15**
Unit II **Regulation of gene expression and Genome activity**	Regulation of gene expression during translation in prokaryotes and eukaryotes, Regulation of Genome Activity During Development: Sporulation in *Bacillus*, Vulva development in *Caenorhabditis elegans*, Development in Drosophila melanogaster. Gene silencing by Histone modification, RNAs in gene regulation		**15**
Unit III **Model organisms**	*S. cerevisiae*- Genome,existence of haploid and diploid cells, facilitating genetic analysis, generating mutations in yeast. *Arabidopsis*- genome life cycle, ease of transformation epigenetics, response to environment. *Mus musculus*- mouse embryonic development and stem cells, ease of introduction of foreign DNA, epigenetic inheritance.		**15**
Unit IV **DNA vectors**	Specialist purpose vectors: Vectors for ssDNA, Expression vectors- for maximizing protein synthesis, to facilitate protein purification, to promote protein solubilization, to promote protein export. Vectors for making RNA probes. BACs, PACs. Cloning in *S.cerevisiae*: YEPs, YRPs, YCPs, YACs, Retrovirus –like vectors, Expression of cloned genes, Specialist vectors, Yeast surface display		**15**

COURSE CODE	TITLE	CREDITS	LECTURES
SIPSBT24	**Bioprocess technology**		
Course Objectives	Students will be exposed to concepts of fermentation technology They will also be learning about the applications of enzymes and microbes in various food processing and packaging		
Unit I Concepts of basic mode of fermentation processes	Strain improvement for increased yield and other desirable characteristics; Upstream processing: Media formulation; Sterilization, Bioreactor designs; classification of fermenters; Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermenter design mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters	**4**	**15**
Unit II Applications of enzymes in food processing	Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed proteinetc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.		**15**
Unit III Applications of Microbes in food process operations and production	Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and acids; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.		**15**
Unit IV Food processing and food packaging	Food Processing: Ambient-temperature processing, heat processing and processing by removal of heat Post processing operations: Coating or enrobing, packaging and storage		**15**

PRACTICALS

SIPSBTP21 Metabolism

1. Detection of Phenylalanine for PKU by spot test and chromatography.
2. Saponification value of fats
3. Extraction of lipids from any oil seed using soxhlet apparatus and quantification.
4. Isolation of cholesterol and lecithin from egg yolks.
5. Study of effect of inhibitors on Enzyme activity
6. Study of Km and Vmax
7. Titration curve of amino acids

SIPSBTP22: Immunology

1. *In-vitro* demonstration of phagocytosis and calculating phagocytic index.
2. Demonstration of HLA typing.
3. Latex bead agglutination / precipitation test for detection of rheumatoid factor (RF).
4. Separation of lymphocytes on Ficoll-Histopaque, viability count.
5. Field visit
6. Vaccine preparation and sterility testing

SIPSBTP23 Molecular Biology

1. Mutagenesis
2. AMES test
3. Conjugation
4. Detection of GMO using PCR
5. Plasmid DNA extraction and detection using agarose gel electrophoresis
6. Elution of extracted plasmid from Agarose gel and quantification

SIPSBTP24: Industrial biotechnology

1. Demonstration of: Plackett-Burman design for formulation of fermentation media.
2. Pigment production and isolation from a microbial source (yeast, fungi or bacteria)
3. Study of enzyme activity of cellulase
4. Immobilization of yeast cells and determination of its invertase activity
5. Detection of different food enzymes by simple tests (amylase, catalase, invertase, papain, pectinase, pepsin).
6. Study of pickling process (sauerkraut / pickled cucumbers) with respect to physical, chemical / biochemical and biological changes occurring during the pickling process.

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EVALUATION SCHEME

The performance of the learner shall be evaluated into TWO Parts.
The learner's performance shall be assessed by Internal Assessment of **40 Marks** and Semester End Examination (theory) of **60 Marks for each term**.
Practical examination will be conducted at end of each semester for **200 Marks**.
The allocation of marks for the Internal Assessment and Semester End Examinations are as follows:-

Internal Assessment – 40 Marks

Semester End Examination – 60 Marks

S. No.	**Particulars**	**Marks**
	All questions are compulsory Number of questions – 5 (Five) Each question carries 12 Marks	
1.	Q1 – Question based on Unit I	12 Marks
2.	Q2 – Question based on Unit II	12 Marks
3.	Q3 – Question based on Unit III	12 Marks
4.	Q4 – Question based on Unit IV	12 Marks
5.	Q5 – Short notes from Unit I-IV	12 Marks
	TOTAL	**60 Marks**