JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)

"A" Road, Churchgate, Mumbai - 400 020, India.

Affiliated to
University of Mumbai

Program : BSc

Proposed Course : Biotechnology

Semester V

Credit Based Semester and Grading System (CBCS)

With effect from the academic year 2020-21

Semester V

COURSE CODE	COURSE TITLE	CREDITS	LECTURE/ WEEK
SBT501	ADVANCED IMMUNOLOGY AND CELL BIOLOGY	04	04
SBT502	MAMMALIAN PHYSIOLOGY	04	04
SBT503	BIOCHEMISTRY,BIOINORMATICS AND ADVANCED BIOANALYTICAL TECHNIQUES - I	04	04
SBT504	APPLIED BIOTECHNOLOGY	04	04
SBTP501	PRACTICAL OF SBT501 AND SBT502	04	08
SBTP502	PRACTICAL OF SBT503 AND SBT504	04	08

SEMESTER V

Course Code: SBT501	Course Title: Advanced Immunology and Cell Biology	4 Credits
Learning Objectives	• To provide insight on role of Cytokines, Interferons and Chemokines in cellular immune response. • To develop comprehensive understanding of cancer immunology and immunology of immune-deficiency diseases. • To provide the basic understanding regarding prerequisites for any cell signalling process. • To learn about the various types of ligands, receptors and other biomolecules involved in signal transduction and to recognise the cellular outcomes as a result of these.	
Course description	This course aims to impart an in-depth understanding about mechanisms of cytokine biology. Through this course students will learn about cytokine receptor biology and will understand cytokine mediated signal transduction. Further students will develop an understanding of therapeutic applications of cytokines. This course will impart knowledge related to leukocyte migration, inflammation and various agents that participate in inflammatory process in detail. This course will further equip students with greater understanding of cancer biology, oncogenes and tumour development and management of cancer through immunotherapy and drugs. Students will also learn about T and B cell immunodeficiency and acquired secondary immunodeficiency, vaccines and other therapeutic approaches to combat cancer and HIV. Signal transduction refers to the process by which cells detect signals/ information in their environment and convert it to different physiological outcomes. This would mainly involve the action of ligands (signals) and receptors (receivers of the specific ligand) leading to specific downstream response and the required physiological effect. Hence in this course, the student will learn about the different types of cell signalling, ligands and receptors involved and some specific examples of cell responses. Thus the student should be able to appreciate the importance of the role of cell signalling in growth, survival, death or general fate of a cell in response to various stimuli.	

	THEORY	60 lectures
Sub Unit	**Unit 1: Immune Effector Mechanisms**	**15 lectures**
1.	Introduction to cytokines, Interferons. Properties and functions of cytokines.	
2.	**Cytokine receptor biology**. Cytokine receptor families. Cytokine receptor mediated signalling.	
3.	Cytokine Antagonists. Cytokine related diseases. Cytokine in immunotherapy. Cytokine in haematopoiesis.	
4.	**Leukocyte adhesion and migration** Cell adhesion molecules. Chemokines. Multistep paradigm of leukocyte Recirculation and Extravasation.	
5.	Inflammation – Localised or systemic. Role of Neutrophils. Role of antigen persistence, TNF α and IFN γ in Chronic inflammation. Anti-inflammatory agents.	

Sub Unit	Unit 2: Immune Response in Health and Disease - I	15 lectures
1.	**Immune system and Cancer** Origin and terminology associated with cancer. Malignant transformation of cells. Cancer associated Proto- Oncogene, Oncogene.	
2.	**Tumours of immune system.** Tumour-antigens. Antitumor antibodies and progression of tumour. Cancer immunotherapy and vaccines-Case studies.	
3.	**Immunodeficiency Diseases** T and B cell dependent immunodeficiency. Immunodeficiency of myeloid lineage and affected Innate responses. Immunodeficiency related to complement dysfunction.	
4.	**Acquired or secondary Immunodeficiency** HIV and Retrovirus. HIV-1 aetiology, replication cycle. HIV and inhibitory drugs. Clinical focus on preventive measures- vaccines. Advancement in Cancer and HIV research – Indian and global scenario.	
5	**Emerging Diseases – Immunological implications** SARS MERS SARS – CoV- 2 (COVID-19)	

Sub Unit	Unit 3: Cell Signalling - I	15 lectures
1.	**Introduction:** Cell signalling; Ligands and Receptors; Types – Autocrine, Endocrine, Paracrine; Role of gap junctions; Morphogens; Seven major classes of cell surface receptors.	
2.	**Signalling Molecules and Cell-Surface Receptors:** Steps involved in communication by extracellular signals; Lifetime of an intracellular molecule; Activation of signalling pathways; Ligand-binding and effector specificity of receptors; Maximal Cellular Response; Sensitivity of a cell to external signals; binding assays; Signal termination. Bacterial signalling. Cell signalling in plants.	
Sub Unit	**Unit 4: Cell Signalling – II**	**15 lectures**
1.	**Role of biomolecules involved in signal transduction:** Extracellular messengers; Second Messengers. Role of calcium and calmodulin. GTPase Switch Proteins; Protein Kinases and Phosphatases. G Protein–Coupled Receptors; Receptor Protein Tyrosine Kinases. Lipids in cell signalling. Nuclear Receptors.	
2.	**Apoptosis:** Definition; Apoptosis versus necrosis; Significance of apoptosis. Fate of a cell; Caspases. Extrinsic pathway and Intrinsic pathway.	

3.	**Cancer:** Role of growth factors and receptors in carcinogenesis - RAS, NFkB, Wnt signalling in cancer.	
CA **(Continuous Assessment)**	CA1- Written test (Unit 3/4) CA 2- Review / Summary of Research paper (Unit 1/ 2)	
References:	• Kindt T. J., Goldsby R. A., and Osborne B. A. (2007). Kuby Immunology. 6th Edition. W.H. Freeman And Company. • Abbas A. and Lichtman A. (2014). Cellular and Molecular Immunology. 8th Edition. Elsevier Saunders. • Ananthanarayan R. and Panikar C. K. J. (2009). Textbook of Microbiology. 8th Edition. Universities Press. • Rao C. V. (2007). Immunology. 2nd Edition. Narosa Publishing House Pvt. Ltd. • Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd. • Nelson D. L., and Cox M. M. (2008). Lehninger Principles of Biochemistry. 5th Edition. W. H. Freeman and Company. USA. • Karp G. (2010). Cell Biology. International Student Version. 6th Edition. John Wiley and Sons, Inc. • Alberts B., Johnson A., Lewis J., Raff M., Roberts K., and Walter P. (2008). Molecular Biology of the Cell. 5th Edition. Garland Science. Taylor & Francis Group. • Lodish H., Berk A., Kaiser C., Reiger K.M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P., and Scott M.P. (2013). Molecular Cell Biology. 7th Edition. W.H. Freeman and Company. USA. • Cooper G. M., Robert E., and Hausman S. (2013). The Cell – A Molecular Approach. 6th Edition. ASM Press.	

Course code: SBT502	Course Title: Mammalian Physiology	4 Credits
Learning Objectives	• To introduce the concept of developmental biology and provide insight into the organism's level of development. • To enable students understand concepts of endocrinology with an emphasis on synthesis, Physiological role , related disorders, diagnostic measures and available therapy related to group II hormones. • To enable students develop understanding of basics of Neurobiology. • To help build the concept of the various types of stem cells and their properties in order to culture and use them. • To create awareness about the ethics, safety and regulatory issues underlying stem cell research and application. • To understand the recent field of tissue engineering and study the scope, challenges and various applications.	
Course description	Developmental biology is the study of initiation and construction of organisms. This course will introduce students to the process of development starting with the organismal level which includes general stages in the cycle of life and formation of the three germ layers that later give rise to organs. It will further introduce students to experimental techniques used by early embryologists in understanding cellular development by tracking cells and creating maps. Lastly it will give an insight into medical embryology- study of birth defects in infants. Through the course in Endocrinology students, will learn about endocrine glands and molecules. They will understand processes involved in secretion of endocrine molecules by endocrine glands, classification of endocrine molecules and mode of action of group II hormones. Students will learn detailed functions, related disorders, diagnosis of disorders, and therapies for management of imbalances associated with group II hormones. Through the Neurobiology curriculum students, will learn basics of cellular and molecular Neuroscience. They will understand the organization of nervous system, neurotransmitters, and synapse. They will further introduced with basic regulatory systems and techniques involved in diagnosis of neurological disorders. The stem cell course is designed to enable the student to be well versed with the different types of stem cells in terms of their properties, how they can be isolated and used in research and medicine. The topic of tissue engineering aims to give an overall insight in terms of research and application of this exciting method that is helping individuals with disease or accidents have a better quality of life.	

	THEORY	**60 lectures**
Sub Unit	**Unit 1: Developmental Biology-I**	**15 lectures**
1.	Introduction to developmental biology and model organisms in developmental studies. The cycle of life- fertilization, cleavage, gastrulation, organogenesis, metamorphosis and gametogenesis. Life cycle of frog.	
2.	**Comparative embryology** Theories of development - Epigenesis and preformation theories.	
3.	**Formation of the primary germ layers**- ectoderm, mesoderm and endoderm and early organogenesis.	
4.	**Keeping track of moving cells**- cell lineages and fate maps.	
5.	**Methods for cell tracking**- direct observation, dye marking, genetic labelling, transgenic DNA chimeras.	
6.	**Study of deformations in embryo** - Medical embryology and teratology.	
	Unit 2: Human Endocrine System - I	**15 lectures**
1.	Basic function of Endocrine system. Difference between Endocrine, Paracrine and Autocrine glands Introduction to human Endocrine system Hierarchy of endocrine glands, and their physiological role in intracellular communication. Feedback control mechanisms in endocrinology. Classification of hormones based on chemical composition and mode of action. Group I hormones.(Brief overview)	

	Group II hormones with mode of action.	
2.	**Anterior pituitary hormones**.	
3.	**Posterior pituitary hormones** - Oxytocin –Structure, Secretion, role, deficiency disorders. ADH- Structure, Secretion, role, deficiency disorders.	
4.	**Thyroid hormones** - synthesis, functions and related disorders.	
5.	**Hormones of Pancreas**- **Insulin** Discovery and history, Nobel prizes. Precursor of active insulin- preproinsulin and pro insulin, Structure of active insulin, Inducers and antagonists of Insulin secretion, Physiological and Biochemical role of insulin as major metabolic effector, Mechanism of action of Insulin, Normal value of Blood Insulin and Blood glucose, Renal threshold of glucose, Glucose tolerance curve/ GTT. Disorders related to insulin- Deficiency and hypersecretion Diabetes mellitus, Hyperglycaemia, glucosurea, Ketourea, Atherosclerosis, Myocardial infarction and other related disorders. **Glucagon** - Structure, secretion, Glucagon synthesis at tissue level, role of cAMP, Role of Glucagon in metabolism, Antagonist role to insulin.	
6.	**Endocrine disorder biology** Diagnostic measures and therapies- Drugs, Diet and exercise. Case studies – rDNA technology and insulin. TSH, T3, T4 as major metabolic regulators. Advancement in endocrine research –Indian and global scenario. Noble laureates in endocrine Biology.	

Sub Unit	Unit 3: Neuroscience - I	15 lectures
1.	**Introduction:** Fundamentals of neuroscience and basic plan of the Nervous System. Structure and physiology of Brain.	
2.	**Cellular and Molecular Neuroscience:** Cellular Components and organization of Nervous Tissue, Nervous System: Organelles and Their Functions. Electronic Properties of Axons and Dendrites, Membrane Potential and Action Potential. Neurotransmitters: Types and receptors of Neurotransmitters. Synaptic Integration Complex Information Processing in Dendrites.	
3.	**Nervous system development and special techniques for neurologic diagnosis:** Neural Induction and Pattern Formation, Cellular Determination, Neurogenesis and Migration Synapse Formation and plasticity. Techniques: MRI,CT Scan and PET.	
4.	**Regulatory systems:** The Hypothalamus: An overview of regulatory systems**.** Neural regulation of the cardiovascular system (Breathing, Food and Water Intake, Circadian Time-keeping, Sleep, Dreaming). Addiction.	
Sub Unit	**Unit 4: Stem Cell Biology**	**15 Lectures**
1.	**Introduction:** Definition; Some key terminologies involved.	
2.	**Classification:** Origin, types and salient features / properties of stem cells; Advantages and disadvantages.	
3.	**Culturing and maintenance:** Sources, isolation, harvesting, processing of stem cells.	
4.	**Tissue engineering:** Concept and significance; Biomaterials; Stem cells and biomaterial scaffolds in tissue engineering.	

5.	**Applications:** In medicine and various disease conditions: Stem cell transplantation; Gene therapy; Regenerative medicine; Neurodegenerative diseases - Parkinson's, Alzheimer's. Spinal Cord Injuries; Tissue system failures - Cardiomyopathy; Kidney failure; Liver failure; Diabetes; Cancer; Haemophilia. Tissue engineering applications for replacing cartilage, bone, skin. Imaging of stem cells.	
6.	**Bioethics and Regulation**: Stem cell research; Challenges; Safety; Ethics; Regulatory considerations; FDA requirements for stem cell therapy.	
CA **(Continuous Assessment)**	CA1- Written test CA 2 - Survey – Endocrine health (Unit 2) / Project proposal on stem cell application (Unit 3)	
References	• Gilbert S. (2010). Developmental Biology. 9th Edition. Sinaeur Associates, Inc. USA. • Alberts B., Johnson A., Lewis J., Raff M., Roberts K., and Walter P. (2008). Molecular Biology of the Cell. 5th Edition. Garland Science. • Guyton, A. C., and Hall. (2011). Textbook of Medical Physiology. 12th Edition. J. E. Saunders. • Nelson D. L., and Cox M. M. (2005). Lehninger Principles of Biochemistry. 4th Edition. W. H. Freeman and Company. USA. • Voet and Voet. (2010). Biochemistry. 4th Edition. John Wiley and sons, USA. • Murray R. K., Granner D. K., Mayes P. A., and Rodwell V. W. Harper's Illustrated Biochemistry. 27th Edition. McGraw-Hill publication. • Satyanarayana U., and Chakrapani U. (2017). Biochemistry. 4th Edition. Books & Allied (P) Ltd. • Srilakshmi. (2017). Nutrition Science. 6th Edition. New Age International publishers. • Tandon N.P, Bijlani V, Wadhwa.S. (1991). Lectures in Neurobiology Wilsey Eastern Limited. • Luo L. (2015). Principles of Neurobiology. 1st Edition. Garland Science. • Matthews G. Gray. (2000). Neurobiology: Molecules, cells and systems. Blackwell publication. • Squire R., Larry, Bloom E. F., Spitzer. C. Nicholas, Lac Du. Sasctia, Ghosh Anirvan. (2008). Fundamental Neuroscience. 3rd Edition. Elseivier Academic	

	Press. • Ropper. H. Allan, Samuels. A. Martin. (2019). Adam's and Victor's Principles of Neurology. 11th Edition. McGraw-Hill Education. • Deb K., and Totey S. (2009). Stem Cells: Basics and Applications. Tata McGraw Hill. • Lanza R., and Atala A. (2013). Essentials of stem cell biology. 3rd Edition. Academic Press. • Lanza R., Langer R., and Vacanti J. (2013). Principles of Tissue Engineering. 4th Edition. Academic Press. • Meyer U., Meyer T., Handschel J., and Wiesmann H. (2009). Fundamentals of Tissue Engineering and Regenerative Medicine. Springer. • Freshney I. R. (2010). Culture of Animal Cells. 6th Edition. Wiley-Blackwell. • Gangal S. (2010). Principles and Practice of Animal Tissue Culture. 2nd Edition. Universities Press (India) Pvt. Ltd.

Course Code: SBT503	Course Title: Biochemistry, Bioinformatics and Advanced Bioanalytical Techniques - I	4 Credits
Learning Objectives	• To enable students understand various metabolic reactions leading to carbohydrate synthesis in human, plants and prokaryotic cells. To acquaint students with various regulatory mechanisms involved in cellular carbohydrate anabolism. • To acquaint students with modern techniques of In-silico analysis through various platforms that is offered by bioinformatics. • To impart knowledge related to various databases and their applications in modern biotechnology. • To study the basic principle, applications and types of advanced electrophoretic, chromatographic and mass spectrometric techniques with emphasis on working of the entire instrument. • To understand the various column chromatographic techniques and their applications.	
Course description	This course aims at imparting knowledge, understanding and applicability of biochemical pathways and reactions leading to carbohydrate biosynthesis. This course will further enable students understand role of various enzymes and other bio molecules in prokaryotic, eukaryotic and human cellular carbohydrate anabolism. The course on Bioinformatics will introduce students with the modern Biotechnology tools. Online recourses in the form of various Bioinformatics Databases and their role in management, processing and analysing Biological information would be the highlight of this course. Students will be able to describe working of advanced electrophoretic, chromatographic and mass spectrometric techniques. Students will be able to apply principles of advanced analytical techniques for separation/resolution and analysis of various important biochemical components	
	THEORY	**60 lectures**
Sub Unit	**Unit 1: Carbohydrate Biosynthesis**	**15 lectures**
1.	**Gluconeogenesis in humans:** Concept and significance of intracellular glucose synthesis. Major pathways of human gluconeogenesis. Reversal of EMP- overcoming three irreversible reactions of EMP. Integration of TCA in gluconeogenic mechanisms.	

	Gluconeogenic amino acids, Glucose-alanine cycle. Other gluconeogenic biomolecules. Regulation of Gluconeogenesis at cellular and molecular levels.	
2.	**Biochemical processing of of glycogen in human** Glycogen – human storage polysaccharide, major organs involved in glycogen processing. Enzymes and reactions involved in Glycogenolysis in human system. Enzymes and reactions involved in Glycogenesis in human system. Regulation of glycogen metabolism at cellular and molecular levels. Contribution of Cori's Lab, Glycogen storage disease and other disorders related to glycogen metabolism.	
3.	**Galactose metabolism** - Conversion of galactose to glucose. Disorders related to carbohydrate metabolism in humans.	
4.	**Biosynthesis of Peptidoglycan in Prokaryotes**: Architecture of Gram positive and gram negative cell wall. NAGA and NAMA synthesis from D Fuctose-6 PO_4, and Construction of bacterial cell wall. Role of Dolichol as transporter. Significance of peptidoglycan from bacterial and disease perspective. Peptidoglycan and antibacterial drug interaction; Park nucleotides. Case studies.	
5.	**Biosynthesis of starch and sucrose in plants**: Role of Starch synthase and Alternate site insertion mechanisms. Reactions catalysed by Starch branching enzyme. Reactions of sucrose synthesis. Integrated regulation of starch and sucrose synthesis in plant cells.	

Sub Unit	Unit 2: Bioinformatics - I	15 lectures
1.	**Introduction to Bioinformatics**: Scope, Goals and Limitations of Bioinformatics. **Journey of Bioinformatics.** **Applications of Bioinformatics**: Nucleotide sequence analysis, phylogenetic analysis, protein structure study and prediction, docking studies.	
2.	**Study of Databases:** Concept and significance of databases. Classification of databases based on type of output: Sequence Database- NCBI, DDBJ, EMBL, PIR (protein sequence). Structural Database- PDB, ExPAsy, Uniprot KB, SWISS-Prot. Specialized Databases- Genome Databases (Fly, Worm database) and OMIM. Expression Database - SIENNA 2D.	
3.	**Study of Databases**: Classification of databases based on type of data: Primary database E.g. - PDB Secondary Database E.g. - CATH	
4.	**Data Formats in Bioinformatics**: Input formats like FASTA and GenPept.	
5.	**BLAST** **Phylogenetic analysis**	
Sub Unit	**Unit 3: Advanced Analytical Techniques - I**	**15 lectures**
1.	Advanced Electrophoretic Techniques – Principle and working of 2D Electrophoresis, Capillary electrophoresis and Microchip electrophoresis. Application of electrophoretic techniques in research and industry.	

2.	Introduction to chromatography - Principles of chromatography, Chromatographic performance parameters – Retention time, retention factor, Plate height and resolution.	
3.	HPLC, UPLC and HPTLC - Principle, working and application.	
4.	Types of HPLC - Principle, chemistry and specific applications for Adsorption chromatography, Partition chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography, Affinity chromatography.	
5.	Gas chromatography – Principle, columns (packed conventional and capillary columns), detectors (FID, NPD, ECD, etc.), applications.	
Sub Unit	**Unit 4: Advanced Analytical Techniques - II**	**15 lectures**
1.	Mass Spectrometry – Principle of MS, components of MS, Methods used for ionization, Types of Mass analysers and their working principles (Quadrupole mass spectrometry, Ion trap mass spectrometry, Magnetic sector analyser, MALDI-TOF, etc.), Detectors (Electron multiplier and conversion dynode).	
2.	Novel hybrid MS instrument – FTICR-MS, Orbitrap MS, LCMS, GCMS.	
3.	Applications of MS - Structural information, analysis of protein complexes, etc.	
4.	Computing and database analyses for MS.	
5.	Problems on MS.	
CA **(Continuous Assessment)**	CA1- Written test (Unit 1/2) CA 2- Assignment (Unit 3/ 4)	

References:	• Nelson D. L., and Cox M. M. (2005). Lehninger Principles of Biochemistry. 4th Edition. W. H. Freeman and Company. USA. • Voet and Voet. (2010). Biochemistry. 4th Edition. John Wiley and sons, USA. • Murray R. K., Granner D. K., Mayes P. A. and Rodwell V. W. Harper's Illustrated Biochemistry. 27th Edition. McGraw-Hill publication. • Satyanarayana U., and Chakrapani U. (2017). Biochemistry. 4th Edition. Books & Allied (P) Ltd. • Guyton, A. C., and Hall. (2011). Textbook of Medical Physiology. 12th Edition. J. E. Saunders. • Srilakshmi. (2017). Nutrition Science. 6th Edition. New Age International publishers. • Jin Xiong. (2006). Essential Bioinformatics. Cambridge University Press. • Pevsner, Jonathan. (2009). Bioinformatics and Functional Genomics. 2nd Edition. Hoboken, John Wiley and Sons Inc. • Wilson K., and Walker J. (2010). Principles and Techniques of Practical Biochemistry. 7th edition. Cambridge University Press. • Upadhyay A., Upadhyay K., and Nath N. (2009). Biophysical Biochemistry: Principles and Techniques. Himalaya Publishing House. • Veerakumari L. (2006). Bioinstrumentation. MJP Publishers.

Course Code: SBT504	Course Title: Applied Biotechnology	4 Credits
Learning Objectives	• To provide an understanding of genomic and cDNA libraries mainly in terms of their construction and use. • To learn about the impact of rDNA technology using a few examples of applications of rDNA technology. • To obtain a deeper understanding of animal cell culture techniques and familiarization with concepts of safety, and bioethics involved. • To understand the techniques of strain improvement, culture preservation and sterilization. • To study the medium optimization and different types of fermenters used in industry for production of different products along with fermentation economics. • To learn in depth understanding of applications of genetic engineering using plant and animal systems and use transgenic plants and animal systems for human welfare.	
Course description	This course will equip the student to understand the basics of DNA cloning, building of libraries, analysis and screening of DNA sequences. The student will also be introduced to examples of applications of rDNA technology that have revolutionized the pharmaceutical and agricultural industries. This course will prepare the student to better understand the advanced practical aspects and issues in animal cell culture mainly with respect to cell lines, and their maintenance, characterization and preservation. Also, the student will be aware about the issues concerning safety, and ethics associated with the procedures when applied in research, industry or healthcare. Students will be able to formulate media and growth conditions for production of commercially valuable products. Students will be able to describe the design of bioreactors its process parameters .Students will be able to analyze the fermentation economy The course in transgenic plants deals with various genetic manipulations for development of transgenic plants. It acquaints students with the concepts, advanced methodologies and applications of transgenic plants. Students will gain detailed insight related to Plant transformation with Ti-plasmid of *A. tumefactions* and Ti-plasmid derived vector system and genetic engineering of plants using Electroporation, Micro projectile bombardment, Liposome mediated and Protoplast fusion. Further development of transgenic animals will enable students in understanding various technologies for development of transgenic animals like mice, fish and others and will also enable students study the associated applications in modern biotechnology.	

	THEORY	60 lectures
Sub Unit	**Unit 1: Techniques in Genetic Engineering – I**	**15 lectures**
1.	**DNA cloning:** General steps; Restriction enzymes; Vectors commonly used; cDNA cloning.	
2.	**Genomic libraries:** Traditional approach; limitations; current methods in construction of a genomic library; chromosome libraries – advantages and construction.	
3.	**Analysis of DNA sequences:** Maxim Gilbert method; Dideoxysequencing – sequencing primers and the dideoxy sequencing reaction; Pyrosequencing; Next-generation sequencing methods.	
4.	**Assembling and annotating genome sequences:** Screening; Use of DNA probes; Whole-genome shotgun approach; assembling and finishing genome sequences; construction of cDNA library and using cDNA libraries to annotate genes; identifying genes in genome sequences by computation.	
5.	Gene expression in bacterial hosts and analysis of gene products, Reporter gene assay.	
Sub Unit	**Unit 2: Concepts in Animal Cell Culture**	**15 lectures**
1.	**Animal Cell Culture:** Types of animal cell culture; Initiation of a culture; Evolution of cell lines; Senescence; Development of continuous cell lines.	
2.	**Subculture and cell lines:** Subculture and propogation; commonly used cell lines; culture age; culture line designations; choosing a cell line; routine maintenance; subculture.	
3.	**Characterisation:** Need for characterization; record keeping and provenance; authentication; cell morphology; monitoring for contamination.	

4.	**Cryopreservation:** Rationale for Cryopreservation and revival. Principle of cryopreservation	
5.	**Safety, Bioethics and Validation:** Laboratory and general safety; Risk assessment; SOPs; Safety regulations; Biohazards; Bioethics; Validation.	
Sub Unit	**Unit 3: Industrial Biotechnology - I (Upstream processing)**	**15 lectures**
1.	High throughput screening methods and strain improvement for production of secondary metabolites.	
2.	Preservation of cultures - Preservation of industrially important organisms, Quality control of preserved stock, Concept of master culture bank (MCB), Test to ensure reproducibility of the MCB.	
3.	Medium Optimization – Introduction to statistical designs for medium optimization- Placket Burman and RSN.	
4.	Sterilization and achievement of aseptic conditions.	
5.	Types of Bioreactors: Tower fermenter, Air-lift fermenter, deep-jet fermenter, bubble column fermenter, Membrane bioreactor, packed column fermenter, Photobioreactor.	
6.	Production of Acetone, Butanol and Ethanol using *Clostridia* Industrial production of *Rhizobium* and *Bacillus thuringenesis*. Fermentation economics.	
Sub Unit	**Unit 4: Transgenic Plants and Animals**	**15 lectures**
1.	Introduction to development of Transgenic Plants- concept, applications and Bioethical concerns.	
2.	Plant transformation with Ti-plasmid of *A. tumefaciens* and Ti-plasmid derived vector system.	
3.	Physical methods for transferring genes to plants: Electroporation, Microprojectile bombardment, Liposome mediated, Protoplast fusion.	
4.	Introduction to development of transgenic animals - concept and applications and Bioethical concerns.	

	Transgenic mice- Methodology and applications.	
5.	Methodologies- retroviral vector method, DNA microinjection, engineered embryonic stem cell method.	
6.	The cre-loxP recombinase system for genetic engineering in animals.	
7.	Applications of transgenic mice as disease models. Transgenic livestock and transgenic fish.	
CA **(Continuous Assessment)**	CA1- Written test (Unit 3/4) CA 2- (Unit 1/ 2) – Presentation (Case studies)	
References:	• Freshney I. R. (2010). Culture of Animal Cells. 6th Edition. Wiley-Blackwell. • Gangal S. (2010). Principles and Practice of Animal Tissue Culture. 2nd Edition. Universities Press (India) Pvt. Ltd. • Wilson K., and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press. • Russell P. J. (2016). Essential iGenetics. 3rd Edition. Pearson Education. • Russell P. J. (1998). Genetics. 5th Edition. Benjamin/Cummings Publishing Company Inc. • Purohit S. S. (2010). Biotechnology. 4th Edition. Student Edition. • Glick B. R., Pasternak J. J., and Patten C. L. (2010). Molecular Biotechnology. 4th Edition. ASM press. • Primrose S. B., and Twyman R.M. (2014). Principles of Gene Manipulation. 7th Edition. Wiley Blackwell. • Cantor C. R., and Smith C. L. (1999). Genomics. John Wiley & Sons. • Brown T. A. (2016). Gene Cloning and DNA Analysis. 7th Edition. • Shuler M., and Kargi F. (2001). Bioprocess Engineering: Basic Concepts. 2nd Edition. Prentice Hall. • Crueger W., and Crueger A. Biotechnology: A Textbook of Industrial Microbiology. (1990). 2nd Edition. Panima Publishing Corporation. • Casida L. E. (2009). Industrial Microbiology. Reprint, New Age International (P) Ltd, Publishers, New Delhi. • Stanbury P. F., Whitaker A. and Hall S. J. (1997). Principles of Fermentation Technology, 2nd Edition. Aditya Books Pvt. Ltd, New Delhi. • Peppler, H. J. and Perlman, D. (1979). Microbial Technology. Vol. 1 & 2, Academic Press 5. • Purohit S. S. (2007). Biotechnology. 3rd Edition. Agrobios India. • Brown T. A. Genomes. (2017). 4th Edition. Garland Science. • Singh B.D. (2015). Biotechnology. B.Sc. Edition. Kalyani Publishers.	

Semester VPractical

Course Code: SBTP501	Course Title: Practical of SBT501 and SBT502	4 Credits
Learning Objectives	• **To identify different types of WBCs and determine total count** • **To understand Ag and Ab interactions in an immuno-diffusion techniques which is used for diagnosis and prognosis** • **To use statistical tools for conducting survey and analyse endocrine health parameters** • **To acquire skills to study nervous system using microscopy and dissection techniques** • **To understand embryology using chick embryo**	
	1. Study of innate immunity. 2. Differential WBC count. 3. Total WBC count. 4. Radial Immunodiffusion/ Mancini method. 5. Double diffusion - Ouchterlony method. 6. Survey of immune status of individuals and use of Biostatical tools for data analysis. 7. Survey on human endocrine health and statistical analysis. 8. Study the electron micrograph of Nervous tissue. 9. Study of Permanent slides of: a) Medullary nerve fibre: b) TS of Spinal cord c) Mammalian retina 10. Study different communicable and behavioural aspect of eusocial animals (Ant or cockroach) and kinetic motor movements in presence of stimulators by X/T/Y/ BOX Maze test. 11. Dissection & display of Nervous system in (invertebrates) cockroach (vertebrates) – chick brain/goat brain. 12. Study of chick embryo for identification of fore, mid & hind brain areas. 13. Research proposal. 14. Field trip to a research institute/ lab and report writing.	

SBTP502	Practical of SBT503 and SBT504	4 Credits
Learning Objectives	• To use colorimetry technique for estimation of blood sugar • To understand Insilco analysis platforms like NCBI and tools like Phylogenetic analysis • To separate biomolecules using chromatography technique • To encapsulate yeast using chemical method • To separate plasmid DNA and visualise ETBR stained bands using UV • To quantify DNA and RNA using spectrophotometer/ colorimeter • To enrich and isolate bacterial fertilizers. • To write a research proposal	
	1. Determination of blood sugar using GOD- POD method. 2. NCBI and BLAST. 3. Phylogenetic analysis. 4. Chick embryo candling and inoculation methods Demonstration experiment. 5. Paper chromatography. 6. Column chromatography. 7. Encapsulation of yeast and estimation of invertase activity. 8. Plackett Burman test for media optimization. 9. Vitamin B_{12} assay 10. Determination of ethanol content in commercial spirits. 11. Extraction of plasmid DNA. 12. AGE of Plasmid. 13. Estimation of DNA by DPA. 14. Quantitative assay of RNA by Orcinol method. 15. Characterization of a cell culture through observation of morphology. 16. Production of biofertilizers – Rhizobia. 17. Production of biofertilizers – Azotobacteria. 18. Research proposal. 19. Field trip and report writing.	

Note: The Department of Biotechnology offers "Nutrition and Dietetics" as the Applied Component. The Syllabus of the Applied Component is available separately.

Evaluation Scheme

[A] Evaluation scheme for Biotechnology Theory Courses

I. **Continuous Assessment (C.A.)** 40 Marks

(i) C.A.-I: 20 Marks test of 40 mins. Duration

(ii) C.A.-II: 20 Marks - Assignment/Projects/ Presentations/Case studies etc.

II. **Semester End Examination (SEE)** 60 Marks

[B] Evaluation scheme for Biotechnology Core paper Practical courses

Semester End Practical 100 Marks x 2 papers = 200 marks

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