VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Bio Sciences and Technology

M.Sc. Biotechnology

Curriculum and Syllabus

(2023-2024 admitted students)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.
- Impactful People: Happy, accountable, caring and effective workforce and students.
- Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.
- Service to Society: Service to the region and world through knowledge and compassion.

Vision Statement of School of Bio Sciences and Technology (SBST)

- To nurture high-quality bioengineers and science graduates with the potential to innovate, invent and disseminate knowledge for the benefit of society and environment

Mission Statement of School of Bio Sciences and Technology (SBST)

- To offer academic programs to impart knowledge skills to cater to the dynamic needs of the bio sciences and the food industry
- To foster the spirit of innovation and creativity in the young minds in solving the real-time problems arising in society and industry
- To instill confidence, ethics, values, and employability skills in the future citizens to focus on the sustainable growth of the economy

School of Bio Sciences and Technology (SBST)

Our Vision

To nurture high-quality bioengineers and science graduates with the potential to innovate, invent and disseminate knowledge for the benefit of society and environment

Our Mission

- To offer academic programs to impart knowledge skills to cater to the dynamic needs of the bio sciences and the food industry
- To foster the spirit of innovation and creativity in the young minds in solving the real-time problems arising in society and industry
- To instill confidence, ethics, values, and employability skills in the future citizens to focus on the sustainable growth of the economy

Department of Bio Sciences

Mission of M.Sc., Biotechnology

- Apply the principles of molecular biology methods with emphasis on the application of recombinant DNA technology to animals, plants and microbial organisms
- Manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environmental control
- Acquire contemporary knowledge and be eligible for jobs in various sectors of the pharmaceutical and the biotechnological industry

M.Sc. Biotechnology

Programme Educational Objectives (PEO)

PEO	Statements
PEO1:	Excel in professional career and/or higher education by acquiring solid foundation in science, mathematics and advanced technologies
PEO2:	Develop and apply engineering solutions for solving contemporary, social and human issues with realistic constraints suitable for the present need through the use of modern tools
PEO3:	Exhibit professional and ethical standards, effective communication skills, teamwork spirit, multidisciplinary and transdisciplinary approach for successful careers and to be able to compete globally, function as leaders, as entrepreneurs, and manage information efficiently and engage in lifelong learning

Programme Objectives (POs)

POs	PO Statements
1	Having a clear understanding of the subject related concepts and of contemporary issues
2	Having problem-solving ability for social issues
3	Having a clear understanding of professional and ethical responsibility
4	Having cross-cultural competency exhibited by working in teams
5	Having a good working knowledge of communicating in English

Programme Specific Outcomes (PSOs)

PSO Statements

1 Apply the principles of molecular biology methods with emphasis on the application of recombinant DNA technology to animals, plants and microbial organisms

2 Manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environmental control

3 Ability to independently carry out research and development work to solve the practical problems

Category-wise Credit distribution

CREDIT INFO		
S.no	**Catagory**	**Credit**
1	Programme Core	23
2	Programme Elective	22
3	University Core	29
4	University Elective	6
Total Credits		80

Programme Core									
Sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	BST5001	Microbiology	Embedded Theory, Lab and Project	1	2	0	2	4	4
2	BST5002	Advanced Biochemistry	Embedded Theory and Lab	1	3	0	2	0	4
3	BST5003	Cell and Molecular Biology	Embedded Theory and Project	1	2	0	0	4	3
4	BST5004	Immunology	Theory Only	1	2	0	0	0	2
5	BST5009	Analytical Techniques in Biotechnology	Embedded Theory, Lab and Project	1	2	0	2	4	4
6	BST5010	Genetic Engineering	Embedded Theory and Project	1	2	0	0	4	3
7	BST5011	Bioinformatics	Embedded Theory and Project	1	2	0	0	4	3

Programme Elective									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	BST5005	Medical Diagnostics	Theory Only	1.1	3	0	0	0	3
2	BST5006	Tissue Engineering and Regenerative Medicine	Theory Only	1	3	0	0	0	3
3	BST5007	Medical Biotechnology	Theory Only	1.1	3	0	0	0	3
4	BST5008	Industrial Biotechnology	Embedded Theory and Lab	1	2	0	2	0	3
5	BST6001	Cancer Biology and Therapeutics	Embedded Theory and Project	1	2	0	0	4	3
6	BST6002	Stem Cell Biology	Theory Only	1	3	0	0	0	3
7	BST6003	Clinical and Translational Research	Theory Only	1.1	3	0	0	0	3

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8	BST6004	Forensic Science and Technology	Embedded Theory and Project	1	2	0	0	4	3
9	BST6005	Pharmacology and Toxicology	Theory Only	1	3	0	0	0	3
10	BST6006	Medical Informatics	Embedded Theory and Project	1	2	0	0	4	3
11	BST6007	Nutraceuticals	Embedded Theory, Lab and Project	1	2	0	2	4	4
12	BST6008	Marine Biotechnology	Theory Only	1.1	3	0	0	0	3
13	BST6009	Nanobiotechnology	Embedded Theory and Project	1	2	0	0	4	3
14	BST6010	Applied Enzyme Technology	Embedded Theory and Lab	1	3	0	2	0	4
15	BST6011	Metabolic Engineering	Theory Only	1.1	3	0	0	0	3

16	BST6012	Plant Biotechnology	Embedded Theory, Lab and Project	1	2	0	2	4	4
17	BST6013	Bioremediation	Embedded Theory and Project	1	2	0	0	4	3
18	BST6014	Genomics and Proteomics	Theory Only	1	3	0	0	0	3
19	BST6015	Signal Transduction	Theory Only	1	2	0	0	0	2
20	BST6016	Cellular and Molecular Biophysics	Embedded Theory and Project	1	3	0	0	4	4

University Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	BST6099	Masters Thesis	Project	1	0	0	0	0	14
2	EFL6097	English and Foreign Language	Basket	1	0	0	0	0	2
3	MSM5001	Biostatistics	Embedded Theory and Lab	1.1	2	0	2	0	3
4	RES5001	Research Methodology	Embedded Theory and Project	1	1	0	0	4	2
5	SET5001	Science, Engineering and Technology Project - I	Project	1	0	0	0	0	2
6	SET5002	Science, Engineering and Technology Project - II	Project	1	0	0	0	0	2
7	SET5003	Science, Engineering and Technology Project – III	Project	1	0	0	0	0	2
8	STS4777	Soft Skills	Basket	1	0	0	0	0	2

PROGRAMME CORE

Course code	Course title	L	T	P	J	C
BST5001	Microbiology	2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
		v. 1				

Course Objectives:

1. Relate insight on the various aspects of Microbiology
2. Study the microbes present in various ecological niches
3. Inculcate the practical knowledge to the students in the field of microbiology

Expected Course Outcome:

1. Defining the evolution, physiological and growth aspects of microbes
2. Identifying the knowledge on the various medically important bacteria
3. Formulating the central dogma of viral infection and its types
4. Categorizing the knowledge in fungal infections
5. Interpreting the importance of various microbes from different ecological niches
6. Combining the studies on communication between bacteria and designing new methodologies in quorum sensing and metagenomics

Module:1	Basics in microbiology:	4 hours

Classification of microbes - polyphasic taxonomy, microbial cell structures, microbial growth and metabolism

Module:2	Bacteriology:	6 hours

Human microbiota, Epidemiology, pathogenesis, treatment and prophylaxsis – wound infections, Upper and lower respiratory tract infections, Gastro intestinal infections and genito-urinary tract infections, sexually transmitted diseases, antibiotic resistance.

Module:3	Virology:	3 hours

Medically important viruses – RNA and DNA viruses (Note: Two viruses in each type)

Module:4	Mycology	5 hours

Superficial, systemic and opportunistic, Vector borne diseases - Malarial parasite, Leishmaniosis and Filariasis

Module:5	Microbes in Biome:	3 hours

Extremophiles and its types, application of microbes from various ecological niches – Hydrothermal vent, unexplored forest soil and marine sediments

Module:6	Industrial microbiology:	4 hours

Industrially important microbes and its applications, Production of various fermented products – Enzymes, cheese, wine and beer, probiotics and its bioactive compounds in human benefits

Module:7	Recent developments in Microbiology:	3 hours

Biofilm and quorum sensing, Quorum quenching, Metagenomics for bioprospective approach – Next-generation sequencing and pyrosequencing

Module:8	Contemporary issues:	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Willey, J., 2014. Prescott, Harley and Klein's microbiology - 9th international ed./Joanne M. willey, linda M. sherwood, christopher J. woolverton. New York: McGraw-Hill Higher	
Reference Books		
1.	Ananthanarayan and JayaramPaniker (2013), "Text book of Medical Microbiology", 9th edition. Orient Longman publications.	
2.	Cappuccino, J.G. and Sherman, N., 2013. *Microbiology: a laboratory manual* (10th Edition). Pearson/Benjamin Cummings.	
3.	Recent publications in the relevant field	
List of Challenging Experiments (Indicative)		
1.	Isolation and purification of bacteria from various environments	2 hours
2.	Isolation and purification of fungus from various ecological niches – Slide culture technique and hyphal tip method	2 hours
3.	Morphological characterization of the bacteria by staining and Non-staining methods	2 hours
4.	Morphological characterization of the fungi by LPCB staining	2 hours
5.	Biochemical characterization of bacteria by IMViC, catalase, oxidase, TSI, carbohydrate fermentation tests	2 hours
6.	Screening of the bacterial isolate for various traits like bioactive compound production	2 hours
7.	Screening for pigment producing fungi	2 hours
8.	Mass production of the effective bacteria and fungi	2 hours
9.	Extraction and confirmation of the screened trait	2 hours
10.	Detection of candidate gene responsible for the specific trait	2 hours
	Total Laboratory Hours	**20 hours**
Mode of Evaluation: CAT/Assignments/Quiz/Project/FAT		
Project 'J' component		

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5002	Advanced Biochemistry	3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
		v.1				

Course Objectives:

1. Explain the basic molecular properties of biological molecules
2. Demonstrate how the structure of biological molecules dictates function
3. Illustrate how regulatory systems maintain homeostasis in biological system

Expected Course Outcome:

1. Relate the key principles of biochemistry at an advanced level
2. Translate the importance of biological macromolecules and their role in living systems
3. Summarize an advanced level of understanding about the structure and function relationship of proteins
4. Interpret the correct folding of proteins for their right function
5. Compare the role of lipids in biological systems and movement of molecules across membranes
6. Illustrate how the enzymes catalyse reactions as well as the enzyme kinetics
7. Compile the different metabolic pathways, their interconnections and their regulation in living organisms

Module:1	Carbohydrates and Glycobiology:	5 hours

Classification of carbohydrates, glycosaminoglycans, proteoglycans, sialic acid, lectins, carbohydrate arrays, glycans in health and disease, glycomimetics, Applications of glycoconjugates.

Module 2	Protein Structure and Function:	6 hours

Classification of amino acids and titration curves; biologically important peptides; Proteins- levels of organization; Ramachandran's plot; Structure and function of Mb, Hb and collagen.

Module:3	Protein Folding and Characterization:	5 hours

Protein folding- molecular chaperones, thermodynamics of folding and unfolding, models of protein folding, misfolding diseases, protein purification and structure investigation, sequencing, and solid phase Merrifield peptide synthesis.

Module:4	Membrane Transport and Nucleic acids:	6 hours

Classification of lipids; lipid bilayers, micelles, liposomes, membrane structure and assembly, transport of molecules across membrane-channels and pumps, model membrane systems and their applications; Structure of DNA and RNA, DNA reassociation kinetics, chromatin.

Module:5	Enzyme Kinetics:	5 hours

Properties of enzymes, classification, Michaelis Menten equation, kinetic parameters, Lineweaver -Burk plot, factors affecting enzyme activity, enzyme inhibition, multisubstrate reactions, enzyme units.

Module:6	Molecular Basis of Enzyme Catalysis and Regulation:	5 hours

Different catalytic strategies, Mechanism of RNase, chymotrypsin, carbonic anhydrase and lysozyme; Regulation of enzymes by- allosteric control, covalent modification, proteolytic

cleavage and isoenzymes.		
Module:7	**Regulation of Metabolic Pathways and Bioenergetics:**	**11 hours**
Metabolism; Glycolysis, TCA cycle, gluconeogenesis, glycogen metabolism & their regulation; Fatty acid biosynthesis and oxidation; Biosynthesis of purine & pyrimidine nucleotides; Over view of amino acid biosynthesis & urea cycle. Bioenergetics-Thermodynamic principles, structure & function of individual complexes of electron transport chain (ETC) in mitochondria, oxidative phosphorylation, shuttle systems, Inhibitors of ETC, uncouplers. Photosynthetic electron transport & regulation.		
Module:8	**Contemporary issues:**	**2 hours**
Industry expert lecture on recent advances in biochemistry and contemporary issues		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	David Lee Nelson, Michael M. Cox. Lehninger Principles of Biochemistry. WH Freeman;7th ed. (2017).
2	Jeremy M. Berg, John L. Tymoczko, LubertStryer. Biochemistry.7th Edition, Palgrave MacMillan (2011)
3	Donald Voet, Judith G. Voet. Biochemistry. 4th Edition, Wiley India Pvt Ltd (2011)

Reference Books

1.	Christopher K. Mathews, Kensal E. van Holde, Dean R. Appling, Spencer J. Anthony-Cahill Biochemistry. Prentice Hall; 4th Edition (2012).
2.	Reginald H. Garrett, Charles M. Grisham. Biochemistry. Brooks Cole 5th Edition (2012).
	David Bender, Kathleen M. Botham, Robert Murray. Harpers Illustrated Biochemistry. 29th Edition, McGraw-Hill Medical Publishing (2012).
3.	Thomas M. Devlin, Textbook of Biochemistry with Clinical Correlations. 7th Edition, John Wiley & Sons (2010).
4	Robert A. Horton, Principles of Biochemistry.5th Edition, Pearson Educacion (2011).
5	Richard A Harvey, Denise R Ferrier, Lippincott's Illustrated Reviews Biochemistry. 5th Edition, Lippincott Williams and Wilkins (2010).
6	Philip W. Kuchel and G.B. Ralston. Schaum's Outline of Biochemistry, Third Edition Int. Ed., McGraw-Hill Book Co (2011).
7	Trudy McKee, James R. McKee Biochemistry: The Molecular Basis of Life, 6th Edition Oxford University Press, (2015).
	Mode of Evaluation: CAT / Assignment / Quiz/ FAT

Recommended by Board of Studies	03-08-2018		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5003	Cell and Molecular Biology	2	0	0	4	3

Pre-requisite	Nil	Syllabus version
		v. 1

Course Objectives:

1. This course will outline students to the dynamic relationships between cell structure and the biochemical reactions that are necessary for cell growth, differentiation, survival and death with an emphasis on eukaryotic cells
2. Familiarization of students with the experimental approaches used in molecular biology principles.
3. Inferring the concepts and mechanisms related to cell and molecular biology

Expected Course Outcome:

1.Extend the Concepts of Cell and Molecular biology to apply in various research areas

2.Illustrate hypotheses and select, adapt and conduct molecular and cell-based experiments to either confirm or reject the hypotheses.

3. Attain a basic conceptual knowledge how gene expression is regulated at different levels, how tissue-specific expression is achieved and exemplify how gene expression can be manipulated and studied experimentally

4.Understand and build the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching and basic research.

5. Inspect relevant information from research publications dealing with issues of cell and molecular biology and assess and relate the information to the context of cell biology

6. Compile an appreciation for all levels of biological organization, including the molecular, cellular, organismal, and systems levels.

Module:1	Introduction	6 hours

Overview of cellular organelle and their functions- comparison between plant and animal cells; Cell wall; Plasma membrane; Modification of plasma membrane and intracellular junctions; Protoplasm.

Module:2	Membrane transport	6 hours

Overview, membrane dynamics, ATP-powered pumps, non-gated ion channels, movement of water, trans- epithelial transport, voltage-gated ion channels; Membrane trafficking: Endocytosis and

Module:3	The cytoskeleton	6 hours

Dynamics of actin assembly, myosin-powered cell movements, cell locomotion, intermediate filaments.

Module:4	Genes and Chromosomes	6 hours

Molecular definition of a gene, chromosomal organization of genes and noncoding DNA, mobile DNA,functional rearrangements in chromosomal DNA, organizing cellular DNA into chromosomes, organelle DNAs, the interrupted gene, genome evolution, telomeres, nucleosomes, transposition.

Module:5	DNA replication	6 hours

The chemistry of DNA synthesis, the mechanism of DNA polymerase, the replication fork, initiation of DNA replication- helicase, termination of replication- topoisomerase, telomerase.

Module:6	**Transcription and its regulation**	**7 hours**
Prokaryotic and eukaryotic transcription-initiation, elongation and termination; regulation of transcription; RNA splicing and processing-spliceosome, alternative splicing, RNA editing, mRNA transport, catalytic RNA. Regulation of gene expression: epigenetic gene regulation, regulatory RNAs- riboswitches, CRISPR,		
Module:7	**Translation and its regulation**	**6 hours**
Messenger RNA, transfer RNA, ribosome; Initiation, elongation and termination; post-translational modification in cellular functioning; regulation of translation.		
Module:8	**Contemporary issues:**	**2 hours**
Industry experts lectures in the field of Cell and Molecular Biology		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Molecular Biology of the Gene. Seventh Edition (2013). James D. Watson, Tania A. Baker, Stephen
2.	Molecular Cell Biology, Eighth Edition (2013). Harvey Lodish, Arnold Berk. W. H. Freeman Co.,
Reference Books	
1.	Molecular Biology of the Cell. Sixth Edition (2014). Bruce Alberts, Alexander Johnson, Julian Lewis,
Mode of Evaluation: CAT / Assignments / Quiz / FAT	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5004	Immunology	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v.1				

Course Objectives:

1. Simplify the major components of the immune system.
2.Translate the molecular and cellular basis of the development and function of the immune system in states of health and disease.
3. Extend the potential applications and principles of translational and clinical research related to the field of immunology
4. Design the skills necessary for the critical analysis of contemporary literature on topics related to health and diseases.

Expected Course Outcome:

1.Relate and discuss the role of the immune cells in health and disease.
2.Outline the basic mechanisms that regulate immune responses and maintain tolerance
Summarize how the innate and adaptive immune system collaborate to fight infections
3. Translate the understanding of basic mechanisms into identification of biological, clinical and therapeutic implications
4. Construct the knowledge of immunology into clinical decision-making through case studies.
5. Justify the experiments and techniques employed in relevant fields of immunological research and disease diagnosis.

Module:1	Introduction to the Immune System:	4 hours

Overview of the immune system**,** Innate and Adaptive immunity, Hematopoiesis, hematopoietic growth factors and regulation. Cells and organs of the immune system. Stem cells and its clinical uses.

Module 2	Molecular Immunology:	6 hours

Antigens, structure of antigen and its different types. Antibody structure and types. Antigen processing and presentation, mechanism of antigen recognition

Module:3	Major Histocompatibility Complex:	3 hours

MHC organization – Class I, II and III and MHC restriction. Complement system, pathways. Biological consequences and diseases, Cytokines

Module:4	Cellular immunology:	5 hours

Biology of T and B-lymphocytes, T helper cells, Cytotoxic T cells, Signal transduction molecules associated with membrane immunoglobulin and T cells. Importance of co-stimulatory molecules involved in B and T cell activation.

Module:5	Immunopathology:	3 hours

Autoimmunity and autoimmune disorders, Hypersensitivity reactions, transplantation and tumor Immunology, immunotherapy for tumors and autoimmune disorders, immunodeficiency diseases.

Module:6	Therapeutic Immunology:	4 hours

Vaccines, active and passive immunization, DNA and plant based vaccines, AIDS vaccine, Recombinant antigen as vaccine, Monoclonal antibodies and their use in diagnosis.		
Module:7	**Immunotechnology**:	**3 hours**
ELISA, Immunoelectrophoresis, Immuno-blotting, Immunohistochemistry and Immunofluorescence		
Module:8	**Contemporary Issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Janis Kuby (2013), Immunology, 7th edition. By Owen, Punt and Stranford Textbook. W.H freeman and company.

Reference Books

1.	Chapel H, Haeney M, Misbah S and Snowden N,(2014) Essentials of Clinical Immunology 6th Edition, Wiley Blackwell
2.	Kenneth Murphy and Casey Weaver (2016), Janeway' s Immunobiology – The Immune system in Health and disease, 9th edition, Garland Science Publishing (Taylor and Francis Group).
3.	Abbas AK, Lichtman AH, Pillai S (2011) Cellular and molecular immunology, 8th edition, Elsevier Health Sciences
	Mode of Evaluation: Assignments, Seminars, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5009	Analytical Techniques in Biotechnology	2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
		v.1				

Course Objectives:

1. Interpret the various analytical techniques used in life sciences
2. Compare the application of various analytical techniques in biotechnology and related fields
3.Illustrate the scientific understanding of various analytical techniques and interpretation of results

Expected Course Outcome:

1. Relating the key concepts of buffers, HH equation and its applications
2. Outlining the importance of chromatography methods for separation and purification of analytes and establish an advanced level of understanding about HPLC and GC instruments and their applications in research and development
3. Elaborating the importance of electrophoretic procedures for the separation of biological molecules mainly proteins and nucleic acids
4. Examining the importance of centrifugal separation methods in life sciences.
5. Justify the importance of electron and light microscopic techniques for the investigation of finer details of both cellular and non cellular structures
6. Classifying different spectroscopic techniques to understand and elucidate the structure, mechanism of biological molecules

Module:1	Electrochemical Techniques:	3 hours

Acid base theories, pH, Buffers and preparation, Henderson-Hasselbach equation, pH meter, standard hydrogen electrode.

Module:2	Chromatography Techniques-I:	4 hours

Classification of chromatographic methods, Principle, methodology and applications of paper, thin layer, gel permeation, ion exchange and affinity chromatography. Performance parameters.

Module:3	Chromatography Techniques –II:	3 hours

Principle, Instrumentation and applications of High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC). Different types of columns and detectors used in HPLC and GC.

Module:4	Electrophoretic Techniques:	4 hours

Electrophoresis-basic principles, Principle, procedure and applications of paper, cellulose acetate, polyacrylamide and agarose gel electrophoresis, electro-blotting, isoelectric focusing; 2D PAGE, immuno electrophoresis, capillary electrophoresis and Pulsed Field Gel electrophoresis (PFGE).

Module:5	Sedimentation and Centrifugation Techniques:	4 hours

Basic principles of sedimentation, types of rotors, types of centrifuges, Types of centrifugal separation- differential centrifugation, density gradient centrifugation; Principle, instrumentation and applications of preparative and analytical ultracentrifuge.

Module:6	**Microscopy**:	**5 hours**
Properties of light, important concepts in microscopy, Basic principle, instrumentation and applications of - Bright field, Dark field, Phase contrast, Fluorescence and Confocal, Principle, instrumentation and application of- Transmission electron microscope, Scanning *electron microscope*, Atomic force microscope.		
Module:7	**Spectroscopy:**	**5 hours**
Electromagnetic radiation, Transitions in spectroscopy, UV-Visible spectroscopy- electronic transitions, absorption laws, Instrumentation of Single, double beam spectrophotometers; Spectrofluorimetry, chromophores, auxochrome, absorption bands, Applications. Principle, instrumentation and application of –Flame Spectrophotometer, Atomic Absorption Spectrometer, Infra-red spectrophotometer. Over view of – NMR, ESR and MS.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th Edition by Keith Wilson.
2.	Physical Biochemistry: Principles and Applicationsby David Sheehan 2nd Edition, John Wiley & Sons (2009)

Reference Books

1.	Biochemistry Laboratory: Modern Theory and Techniques, Rodney F. Boyer, Pearson Prentice Hall; 2nd Edition (2010).
2.	Bioanalytical Techniques, Sekhar Talluri, I.K. Internationlal Publishing House Pvt. Ltd. (2012)
3.	Biochemical methods of analysis: Theory and applications. Saroj Dua and Neera Garg, Alpha Science Intl Ltd; 1st Edition (2010)

List of Challenging Experiments (Indicative)

1.	Preparation of a buffer using HH equation and determination of buffer capacity.	2 hours
2.	Separation and identification of plant pigments by Thin Layer Chromatography (TLC).	2 hours
3.	Separation of Plant Pigments by silica column chromatography (using silica gel-G).	3 hours
4.	Separation of proteins by gel filtration chromatography (GFC).	3 hours
5.	Purification of lysozyme from egg white by ion exchange chromatography (IEC).	4 hours
6.	Separation of proteins by SDS polyacrylamide gel electrophoresis (SDS-PAGE).	2 hours
7.	Isolation of Genomic DNA and analysis by Agarose gel electrophoresis.	4 hours

8.	Verification of Beer - Lambert's law by UV-Vis spectrophotometer.			2 hours
9.	Determination of sodium by flame photometry.			2 hours
10.	Isolation of plasmid DNA.			4 hours
11.	Demonstration- HPLC, GC, SEM, TEM, AAS, FTIR.			2 hours
			Total Laboratory Hours	**30 hours**
Mode of Evaluation: CAT / Assignments / Quiz / FAT				
Recommended by Board of Studies	03-08-2017			
Approved by Academic Council	No. 46	Date	24-08-2017	

Course code	Course title	L	T	P	J	C
BST5010	Genetic Engineering	2	0	0	4	3
Pre-requisite		Syllabus version				
		v. 1				

Course Objectives:

1. Outlining the methods and techniques involved in manipulation of DNA, RNA and Proteins.
2. Maximize the enthusiasm to know recent developments in the subject.
3. Make students interpret the ethical and environmental problems associated with genetic engineering.

Expected Course Outcome:

1. Translate the key concepts, facts, and theories relevant to gene modification.
2. Create enthusiasm to know the recent developments in the subject.
3. Illustrate the contemporary issues in related field.
4. Build consciousness about the environmental health.
5. Justify the relevance of scientific hypothesis and scientific methodologies.
6. Able to discover scientific knowledge for betterment of life.

Module:1	Introduction to genetic engineering	2 hours

Importance and outline of recombinant DNA technology, organization of genes in the genome, gene expression.

Module:2	Enzymes in genetic engineering	4 hours

Endo- and exonucleases, DNase, RNase; Restriction endonucleases- types, and mechanism of action;restriction modification- methylases; other enzymes- methyl transferases, phosphatases, polynucleotide kinase, polynucleotide phosphorylase; Ligases - types and mechanism of action, linker, adaptor,homopolymer tailing, ligation with DNA topoisomerase; Polymerases- types and mechanism of action;reverse transcriptase.

Module:3	Vectors in genetic engineering	4 hours

Role of promoters and terminators; plasmids- types of plasmids; Bacteriophages- lytic, lysogenic; M13 phage, cosmids. cloning vectors- pBR322, pUC8, pGEM3Z; insertion- and replacement vectors; phage P1vector system; artificial chromosomes- BAC, YAC; Cloning vectors for higher plants- *Agrobacterium*;plant virus based vectors; cloning vectors for animals, viruses as cloning vectors for mammals.

Module:4	Cloning strategies	4 hours

Cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors, and construction of cDNA

library. Construction of genomic libraries. Advanced cloning strategies: multigene cloning and gateway cloning, Ligation independent cloning (LIC), Gibson DNA assembly, Circular

Module:5	Transformation	3 hours

Preparation of competent cells of bacteria; selection for transformed cells physical, chemical and biological methods of gene transfer: physical- microinjection, electroporation, biolistic, ultrasound; chemical- calcium phosphate precipitation method, PEI, dendrimers; biological- liposome mediated; transfection, electroporation, transformation of protoplasts.

Module:6	**Selection and screening of recombinants**	**4 hours**

Genetic selection, identification of recombinants- insertional inactivation, screening for recombinants

lac selection, screening for blue white colonies; Marker genes- endogenous selectable marker genes, dominant selectable marker genes, reporter genes. DNA sequencing by enzymatic and chemical methods: Maxam and Gilbert procedure, Sanger's chain-termination method; shotgun

Module:7	**Techniques & Applications of genetic**	**7 hours**

Polymerase chain reaction (PCR) and its applications; Types of PCR and their applications- multiplex, nested, inverse, real time, quantitative, hot-start, touchdown; Methods of nucleic acid hybridization-

Southern, Northern and Western blotting techniques; Labelling of DNA, RNA and proteins by radioactive isotopes, non-radioactive labelling, autoradiography. Site-directed mutagenesis, exon cloning, chromosome walking and jumping, EMSA, RNase A protection assay, DNAse I foot printing assay, microarrays,

Chromatin immunoprecipitation assay. Applications: Gene cloning in medicine (Insulin, Blood clotting factor VIII); Genetic engineering for human gene therapy; Industrial applications of rDNA technology.

Module:8	**Contemporary Issues:**	**2 hours**

Industry expert lectures on contemporary issues

	Total Lecture hours:	**30 hours**

Text Book(s)

1. Principles of Gene Manipulation and Genomics, Seventh Edition (2014) S.B. Primrose, S.B. and
2. Gene Cloning and DNA Analysis: An Introduction. Seventh Edition (2016) T.A. Brown, Wiley

Reference Books

1. Molecular Cloning. A Laboratory Manual. Volume 1-3. Fourth Edition (2013) Michael R Green and

Mode of Evaluation: CAT / Assignments / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5011	Bioinformatics	2	0	0	4	3
Pre-requisite		Syllabus version				
		v.1				

Course objectives:

1. Spell the concepts and applications of Bioinformatics
2. Demonstrate the bioinformatics skills to solve biological problems
3. Model the Biological databases
4. Construct and evaluate open access biological databases and sequence alignment algorithm
5. Demonstrate about the heuristic algorithms, phylogenetic analysis and structure prediction
6. Simplify the knowledge on the latest trends in new drug discovery

Expected Course Outcome:

1. Infer the solutions to basic bioinformatics problems discuss the use of bioinformatics in addressing a range of biological questions
2. Distinguish how bioinformatics methods can be used to relate sequence, structure and function
3. Categorize central bioinformatics data and information resources
4. Model the principles and algorithms of pairwise and multiple alignments, and sequence database searching
5. Relate pattern matching in bio molecular sequences
6. Justify how evolutionary relationships can be inferred from sequences (phylogenetics)
7. Experiment with basic principles of hidden Markov models and their application in sequence analysis.

Module:1	Bioinformatics database and Resources:	4 hours

File formats (Genbank, Uniprot, PDB), NCBI, RCSB, DDBJ, GenBank, Uniprot-KB, PDB,KEGG, EMP, ExPASY server, GCG utilities, Sequence formats, R package, EMBOSS, Genome Browser, iGEM, Bioconductor

Module:2	Sequence analysis:	4 hours

Measure of sequence similarity; identity and homology, Concept of homologs, orthologs and paralogs. Scoring matrices- PAM, BLOSUM, Sequence Alignment-Needleman Wunsch algorithm, Smith Waterman algorithm, Use of sequence alignments for analysis or nucleic acids and protein sequence, NGS analysis

Module:3	Taxonomy and Phylogeny:	4 hours

Data types used in taxonomy and phylogeny, Phylogenetic trees, Algorithms like maximum parsimony, UPGMA, 16s rRNA typing, Probabilistic models of evolution.

Module:4	Drug Design:	4 hours

Target identification and validation, Analog based drug design- Pharamcophore and QSAR, Docking, De novo drug design-Fragment placements, sequential grow, connection methods

Module:5	Big Data Informatics:	4 hours

Data processing, Parallelism in storage, Open source big data tools, Bioinformatics Challenges		
Module:6	**Structural Bioinformatics:**	**4 hours**
Conceptual model of protein structure, protein structure prediction and modelling – Homology Modeling, Threading, Ab initio- Protein Structure Visualization, Comparison and Classification, CAPRI, Protein Structure Initiative, Computational Proteomics		
Module:7	**Applications:**	**4 hours**
Virtual screening, Pharmacogenomics, Antisense Technology		
Module:8	**Contemporary issues:**	**2 hours**
Industry expert lecture on contemporary issues		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2016.

Reference Books

1.	Bioinformatics- sequence and Genome analysis by Mount D., Cold Spring Harbor Laboratory Press, New York, 2014.
2.	Bioinformatics- From Genomes to Therapies, Vol 1-3, Wiley Inc., 2016.

Mode of Evaluation: CAT / Assignments / FAT

Recommended by Board of Studies		03-08-2017	
Approved by Academic Council	No. 46	Date:	24-08-2017

PROGRAMME ELECTIVE

Course code	Course Title	L	T	P	J	C
BST5005	Medical Diagnostics	3	0	0	0	3
Pre-requisite	Nil			Syllabus version		
				v 1.1		

1.Categorize the knowledge about various types of specimen received in the diagnostic laboratory and the purpose for which they are sent
2.To Interpret the procedures carried out in different laboratories
3.To illustrate the molecular diagnostic and imaging tools to assist the clinical diagnosis.

1. To justify the importance of diagnostic tools and different laboratories
2. To summarize the basis of clinical and haematological tests
3. To infer clinical significance of urine and faeces analysis
4. To construct the techniques in histopathological laboratory.
5. To organize the knowledge of common infectious and non-infectious diseases
6. To explain the basis of common imaging techniques and their applications

Module:1	Introduction:	4 hours

History of diagnostics, importance of medical diagnostics, diagnostic tools.

Module 2	Fields of medical diagnostics	5 hours

Histopathology, serology, biochemistry, haematology and microbiology.

Module:3	Hematological investigation	6 hours

Blood composition, blood sample collection and smear preparation, Differential cell counts – RBC, WBC, Platelets, hemoglobin estimation, erythrocytic sedimentation rate (ESR), Blood platelet count by hemocytometer, and testing of blood glucose using glucometer.

Module:4	Urine and feces analysis:	6 hours

Formation and composition of urine, Physical characteristics of urine, sample collection, detection of abnormal constituents. Fecal formation and stool sample preparation for microscopic evaluation.

Module:5	Histopathology:	6 hours

Biopsy sample collection, tissue sample processing, embedding, sectioning, staining and mounting, histopathological techniques – Hematoxylin & Eosin (H&E) staining and immunohistochemistry.

Module:6	Infectious diseases and Non - infectious diseases	7 hours

Types, causes and molecular basis of the disease, symptoms and diagnosis of infectious disease (Example: tuberculosis, typhoid and malaria) and non- infectious disease (Example: diabetes (Type I and II), rheumatoid arthritis)

Module:7	**Diagnostics using medical imaging**	**9 hours**
Diagnostic radiography, Electrocardiogram (ECG), Ultrasound, Sonography, Positron emission, tomography (PET), Magnetic resonance imaging (MRI) and Computerized tomography (CT) Scan. Applications of medical imaging in the detection and diagnosis of cancer, Recent trends in the field of medical diagnostics, Guest lectures by experts on recent updates		
Module:8	**Contemporary issues:**	**2 hours**
Expert lecture from clinician, academician and industry		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Guyton A.C. and Hall J.E. 2010, Textbook of Medical Physiology, Saunders

Reference Books

1.	Prakash, G. 2012, Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.
2	Macleod J. 2013, Davidson's Principles & Practice of Medicine: A textbook for students and doctors' 22nd Edition. Churchill Livingstone.

Mode of Evaluation: CAT / Assignment /Quiz / Project/FAT

Project: 'J' component

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5006	Tissue Engineering and Regenerative Medicine	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v.1				

Course Objectives:

1. Relate the use of Biomaterials and cell culture in Tissue Engineering
2. Illustrate the significance of scaffold design
3. Distinguish the role of stem cell technology in TE and RM.

Expected Course Outcome:

1. Outline the biological requirement for designed tissue engineering systems
2. Categorize the biomaterials suitable for intended tissue applications
3. Summarize the drug delivery modes in tissue engineering
4. Justify and fabricate the scaffolds for growing biological materials using conventional methods and advanced manufacturing technologies
5. Model tissue regeneration process implying the stem cells and growth factors
6. Design and construct artificial organ upon patient's need.

Module:1	Introduction to Tissue Engineering and Regenerative Medicine:	3 hours

Introduction to Tissue Engineering and Regenerative Medicine. Principles of tissue development and organization. Biology of Regeneration, Basis of Regenerative Medicine, Strategies of Regenerative Medicine

Module 2	Mammalian cell sources, cell culture conditions:	6 hours

Mammalian Cell sources, cell culture conditions: cell container, medium, protocols, 3D culture, Extracellular matrix. Introduction to Stem cells, cell reprogramming, SCNT

Module:3	Biomaterials Classification:	6 hours

Bioinert, biodegradable, bioactive. Types of biomaterials, smart material, drug delivery, cell-material interaction

Module:4	Scaffold fabrication	6 hours

Scaffolds for Tissue Engineering, Classification of scaffold materials - examples, criteria for ideal scaffold, control of architecture, Scaffold design and fabrication techniques

Module:5	Clinical applications:	8 hours

Musculoskeletal tissue engineering, Cardiovascular tissue engineering, Neural tissue engineering. Skin tissue engineering, Expert lecture or Review of present status of clinical tissue engineering

Module:6	Bioartificial Organs	8 hours

Artificial tissue and artificial skeleton. Three dimensional cell culture and tissue growth, 3D printing of tissue, cells and organs. Bioartificial heart, Bioartificial kidney.

Module:7	Tissue regeneration:	6 hours

Tissue Regeneration Driven by Growth Hormones, Stem Cells as source in regeneration of tissues, Therapeutic Applications: Tissue Therapy, Drug-vaccine-viral delivery in RM.		
Module:8	Contemporary Issues:	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Principles of Regenerative Medicine , Anthony Atala, Robert Lanza, James A. Thomson, Robert M. Nerem, 2010 Academic Press
2	Principles of Tissue Engineering (Fourth Edition) Robert Lanza, Robert Langer, Joseph Vacanti, 2014, Academic Press
Reference Books	
1.	Tissue Engineering for Artificial Organs: Regenerative Medicine, Smart Diagnostics and Personalized Medicine, Anwarulhassan, 2017, Wiley – VCH Press
2.	Regenerative Medicine and Tissue Engineering. Jose A. Andrades, InTech, 2013

Mode of Evaluation: CAT / Assignments / Quiz / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5007	Medical Biotechnology	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v. 1.1				

Course Objectives:

1. Demonstrate the advances in medical biotechnology field
2. Compare the biology, diagnostics and treatment opportunities for various diseases
3. Critically analyze the techniques that can be used for diagnostics and treatment

Expected Course Outcome:

1. The students will be able to define the basic of various diseases.
2. The students will be able to interpret the prognostic and diagnostic methods and techniques to identify markers.
3. The students will be able to conclude a clear picture on various biomolecules and molecular therapeutic approaches
4. The students will be able to compile the prophylaxis method, medical information database
5. The students will be able to model the treatment strategies and how to screen compounds for a particular bioactivity.

Module:1	The Biology of disease	8 hours

Infectious diseases, inflammatory diseases, the molecular basis of Senescence and cell death, Neurodegenerative diseases and Chromosome abnormalities.

Module:2	Prognosis and Diagnostics	6 hours

Immunodiagnostics, genetic diagnosis, protein markers and identification of disease specific markers, microarrays, automated workstations, genetic testing-neonatal screening.

Module:3	Therapeutics	6 hours

Monoclonal antibodies, Therapeutic proteins in the treatment of various diseases, Cytokines, hormones, gene therapy, Basic approaches and applications of gene therapy in cancer and genetic disorders.

Module:4	Prophylaxis	6 hours

Vaccines and production, cancer vaccines, medical information databases, prebiotics and probiotics.

Module:5	Disease treatment strategies	6 hours

Rational drug design, important criteria in drug designing, High-throughput compound screening, various new developments in drug delivery and antisense RNA technology

Module:6	Clinical approach	6 hours

Animal models of human diseases including, Cancer, Neurodegenerative diseases and diabetes,

Clinical Trials.

Module:7	**Ethics and regulations**	**5 hours**
Ethics and regulations in clinical research, licensing procedures in India, Intellectual property rights and patents in biotechnology		
Module:8	**Contemporary issues**	**2 hours**
Recent trends in medical biotechnology lectures by industry experts		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Medical Biotechnology, Bernard R. Glick, T.L. Delovitch, Cheryl L. Pattern, ASM Press, 2014.
2.	Biotechnology and Medical Sciences, Firdos Alam Khan, CRC Press, 2014.
Reference Books	
1.	Medical Biotechnology, Firdos Alam khan, Academic Press, 2013.
2.	An Introduction to human diseases: Pathology and Pathophysiology correlations. Leonard V. Crowley, 2012.
3.	Apoptosis: Physiology and Pathology, John C Reed and Douglas R. Green, Cambridge University Press, 2011.

Mode of Evaluation: CAT / Assignments / Quiz / FAT

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST5008	Industrial Biotechnology	2	0	2	0	3

Pre-requisite	Nil	Syllabus version
		v. 1

Course Objectives:

1.Categorize insight on the various aspects biological systems and harnessing of biomolecules
2.Identify various optimization parameters and strain improvement
3.Build the practical knowledge on bioreactors and fermentation process

Expected Course Outcome:

1. Discover the development of industrial biotechnology
2. Formulate the knowledge on mathematical solutions for industrial problems
3. Demonstrate the optimization parameter and sterility maintenance
4. Experiment with the techniques involved in strain improvement
5. Infer the importance of bioreactor and the processes of fermentation along with economics and cost benefit
6. Construct a novel biosystems for upstreaming and down streaming process

Module:1	Introduction to products and fermentation processes:	4 hours

Historical overview; chronological development; recent advances

Module:2	Process calculations:	3 hours

Dimensions, variables and system of units; Basics in chemical and stoichiometric calculations and dimensional analysis; Ideal gas law, ideal mixtures and solution, Dalton's Law of Additive pressures, Amagot's Law of Additive volumes. Mass transfer and diffusion limitations. Heat transfer- equipment,mechanism and calculations; Thermal death kinetics

Module:3	Media standardization and sterilization:	4 hours

Nutrient requirements and their optimization (classical and statistical); Sterilization: physical and chemical treatment; modes of sterilization operation: batch and continuous; sterilization in industries.

Module:4	Strain Improvement:	5 hours

Kinetics of growth, growth curve; mutation, selection and genetic recombination. Case studies in strain improvement for production of organic acids and amino acids.

Module:5	Bioreactor operation& monitoring:	4 hours

Basic instrumental components of a bioreactor; bioreactor configurations - types of bioreactors, modes of operation of bioreactors – continuous stirred tank reactor, batch reactor, fed batch reactor, stirred tank reactor with recycle and reactors in series; reactors for plant cells and animal cells, immobilized reactors.

Module:6	Monitoring of Bioprocess:	4 hours

Process variable measurement and control – temperature, gas and liquid flow, pressure, agitator, pH, biomass, foam formation, weight, dissolved oxygen, inlet and exhaust gas, redox and carbon dioxide; probes for sampling and control; sensors; on-line data analysis for measurement of parameters; basics of computer application in bioprocess.

Module:7	Downstream processing, economics and ethics:	4 hours

Technical feasibility, process development, Environmental safety and Health considerations, Marketability of the product, Capital investments, Plant overheads and depreciation, Profitability Analysis, Patents and		
Module:8	**Contemporary issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Industrial Biotechnology: Sustainable Growth and Economic Success, Eds. W Soetaert, EJ Vandamme, 2010, Wiley-VCH
2.	Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall,Engelwood Cliffs, 2017.
Reference Books	
1.	Stanbury RF and Whitaker A., Principles of Fermentation Technology, Butterworth-

List of Challenging Experiments (Indicative)		
1.	Statistical optimization of media: Plackett-Burman Design and RSM	2 hours
2.	Strain improvement of *Aspergillus niger*	2 hours
3.	Setting up shake flask culture; growth curve & determination of growth by spectroscopy	2 hours
4.	Analysis of growth, C & N and production profile	2 hours
5.	Demonstration of Bioreactor (Application demo)	2 hours
6.	Optimization of parameters for scale up of (3) based on results of (4)	2 hours
7.	Extraction of products/ metabolites	2 hours
8.	Purification by dialysis	2 hours
9.	Purification by chromatographic procedures	2 hours
10.	Characterization by relevant bio-analytical technique	2 hours
	Total Laboratory Hours	**24 hours**
Mode of Evaluation: CAT / Assignments / Quiz / FAT		

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST6001	Cancer Biology and Therapeutics	2	0	0	4	3
Pre-requisite		Syllabus version				
		v.1				

Course Objectives:

1 Building the ability to be socially intelligent with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)
2 Having a clear understanding of the subject related concepts and of contemporary issues
3 Developing problem solving ability- solving personal and social issues
4 Combining a clear understanding of professional and ethical responsibility in facing the outcome and treating the disease
5 Adopting critical thinking and innovative skills
6 Having a good digital footprint and Virtual Collaborating ability
7 Solving problem by computational thinking (Ability to translate vast data in to abstract concepts, and to understand database reasoning)

Expected Course Outcome:

1. Outline and summarize the process of pathology, progression of cancer
2. Identify the etiological mechanism responsible for cancer, available diagnostic, treatment methodologies
3. Make the students to discover with the products or processes which are ultimately aimed in preventing or treating cancer cost effectively
4. Appraise the utility of different analytical techniques that can be used to study the outcome of the disease
5. Construct Omics based methodologies for qualitative and qualitative analysis for the prediction and application for the treatment

Module:1	Overview and Origin of cancer	Hours 4

Introduction, Defining cancer, Current hallmarks of cancer, Carcinogens (environmental pollutants, chemical, viral, radiation), cellular transformation into cancer, Methods in studying carcinogenesis, Cancer as a complex metabolic disorder

Module 2	Tumorigenesis, Oncogene activation, Tumour suppressor inactivation	Hours 4

Discovery of oncogenes and genetic abnormalities, Multi-step tumorigenesis process, Role of tumor suppressor genes inactivation and oncogene activation in tumor pathogenesis

Module:3	Cell cycle Dysregulation	Hours 4

Cell cycle and regulatory proteins, checkpoint measures during DNA damage (involvement of Rb, p53 proteins), Cell cycle modulation in cancer. Apoptosis and Altered Signalling Pathways- Apoptosis, Mechanism, defective apoptotic/cell proliferative mechanisms leading to cancer: Pathways regulating tumor initiation and/or its progression

Module:4	Angiogenesis and Metastasis	Hours 4

Angiogenesis, Hypoxia, Mechanism, Current targeting strategies, Metastasis - Proposed theory and mechanisms, epithelial to mesenchymal transition, interaction of cancer cells with normal cells, clinical interventional measures.

Module:5	Cancer Stem cells, Cell of Origin, Chromosomal Abnormalities	Hours 5
Cancer Stem cells, clinical implications and targeting CSCs, Insight into genomic instability, tissue specificity and cells of origin, mouse models in studying cancer origin, Senescence, immortalization, ageing andTelomere dysregulation in cancer, Chromosomal Modifications, Cancer Epigenetics		
Module:6	**Cancer Therapeutics**	**Hours 4**
Chemotherapy, Surgery and Radiation Therapy; Mechanism, FDA approved Anticancer drugs and FDA approval procedures, Cancer immunotherapy, Therapeutic Screening: Role of cell lines, chemically induced models, knockout mouse model, Xenograft models, patient-derived xenografts (PDXs), Futuristic cancer therapeutics approaches		
Module:7	**Cancer Diagnosis, Risk assessment, Prognosis**	**Hours 4**
Screening methods; conventional and new visualization Techniques - Histopathology, X-ray, CT-Scan, MRI, PET; Molecular Screening and early detection - Cytogenetics, molecular cytogenetics and array based techniques;Cancer markers: promises and challenges, genomic and proteomic technologies in targeting cancer.		
Module:8	**Cancer Informatics (Industry Expert's Lectures):**	**Hours 1**
High throughput sequencing technologies to detect genetic alterations in cancer, Current approaches in genomics and proteomics contributing towards cancer prognosis and early detection, Cancer Databases: The Cancer Genome Atlas, METABRIC		
	Total Lecture hours:	**Hours 30**

Text Book(s)

1.	Text Books and articles: The Biology of Cancer – Robert Weinberg. Edition – 2nd ISBN:9780815342205 - 2013

Reference Books

1.	1. Cancer Sourcebook, Edited by Edited by Karen Bellenir, Omnigraphics, Inc., 2011, ISBN 978-0- 7808-1145-4
2.	2. Cancer cell signalling / edited by Amanda Harvey, John Wiley & Sons, Ltd, 2013, ISBN 978-1-119- 96757-6 (pbk.)
3.	3. The Tumor Microenvironment, Edited by Rebecca G. Bagley, 2010, ISBN 978-1-4419-6614-8 eISBN 978-1-4419-6615-5, DOI 10.1007/978-1-4419-6615-5, Springer New York Dordrecht Heidelberg London
	Mode of Evaluation: Use of technology in teaching, lecture by industry experts, Written examinations, Projects and assignments

Recommended by Board of Studies	03.08.2018		
Approved by Academic Council	No.46	Date	24.08.2017

Course code	Course title	L	T	P	J	C
BST6002	Stem Cell Biology	3	0	0	0	3
Pre-requisite	Knowledge of cell biology is desirable.	Syllabus version				
		v. 1				

Course Objectives:

1. Students will recall and relate the facts and concepts pertaining to this course.
2. Students will combine the cellular, molecular and epigenetic aspects pertaining to stem cells
3. Students will discover the importance of optimization of stem cell culture conditions for effective stem cell therapy

Expected Course Outcome:

1. To Compare different types of stem cells including induced pluripotent stem cells and the extent of their plasticity as well as the basics
2. To Improve the mechanistic interpretation of the cellular and molecular players in stem cell self-renewal, proliferation and differentiation
3. To better assess and interpret the basis for the origin, metastatic potential, cause for relapse and the state-of-the-art in cancer treatment strategies (at the cancer stem cell level)
4. To be able to illustrate and demonstrate the use of appropriate media components for the proliferation and differentiation of the different types of stem cells
5. To be able to prioritize and rephrase the current state-of-the-art issues and challenges in terms of stem cell therapy

Module:1	**Introduction to stem cell Biology**	**5 hours**

Basic definitions and terminologies; Self-renewal and pluripotency; Quiescence vs senescence; Embryonic and adult stem cells; Stem cell debate, politics and ethics

Module:2	**Stem cell niche, epigenetic regulation of stem cell fates and nuclear reprogramming**	**6 hours**

Stem cell niche – Role and molecular characterization; Epigenetic regulation – Histone and DNA modifications, ATP-dependent chromatin modeling; Nuclear reprogramming – Somatic cell nuclear transfer and induced pluripotent stem cells

Module:3	**Signal transduction pathways**	**6 hours**

Canonical and non-canonical Wnt signaling; Sonic hedghog signaling; TGF-β and FGF signaling; BMP and Notch signaling.

Module:4	**Heamatopoietic stem cells**	**6 hours**

HSC subpopulations and the niche, lineage commitment; HSC therapy success stories

Module:5	Mesenchymal stem cells	**6 hours**

Immunomodulatory role and engraftment potential; Therapeutic uses

Module:6	**Cancer stem cells**	**6 hours**

Stem cell models; Cancer metastasis and relapse; Novel cancer drugs

Module:7	**Stem cell culture protocols**	**6 hours**
Feeder-dependent protocol; Feeder-independent protocol; Feeder-free protocol		
Module:8	Stem cell therapies	**4 hours**
Advantages and constraints; Current status of stem cell-based therapies		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Essentials of Stem Cell Biology. 2nd edition. (2009). Academic Press USA.
2.	Stem Book. http://www.stembook.org/.
3.	Recent peer-reviewed papers.
Reference Books	
1.	Yanhong S., Dennis C.O. (Ed.) Stem Cell Research & Therapeutics. Springer. New Delhi. 2010.
2.	Vemuri M., Stem Cell Assays. Humana Press, NJ. 2010.
3.	Newton D.E.Stem Cell Research. Viva Books Pvt. Ltd. Delhi. 2008.

Mode of Evaluation: Use of technology in teaching, lecture by industry experts, Written examinations, Projects and assignments

Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No. 46	Date	24.08.2017

Course code	Course title	L	T	P	J	C
BST6003	Clinical and Translational Research	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v.1.1				

Course Objectives:

1. To construct an overview and examples of how basic science and clinical observations lead to translational research.
2. To motivate the next generation of investigators who will lead cutting edge clinical research into the future.
3. To illustrate the students about the safety, risk assessment and adverse reactions to drug in order to develop problem solving capabilities.

Expected Course Outcome:

1. Rephrase the general ethical frameworks, along with specific ethical principles underpinned by those frameworks, in the context of current developments in biotechnology, clinical practice, and the ethical oversight of research on humans.
2. Build methodologically robust and statistically valid clinical research protocols.
3. Judge the clinical research procedure that complies with highest national and international legal, regulatory and scientific standards.
4. Translate, evaluate and enhance clinical research protocols, ensuring the highest quality research output.
5. Outline the principles of good clinical practice, how to conduct a clinical trial, how drugs are developed and how to manage regulatory documents.
6. Combine the needs for patients, academic partners and industry to complete valid clinical research programmes.

Module:1	Introduction:	3 hours

Definitions, bench-to-bedside concepts, debate, politics and ethics

Module 2	Regulations and regulatory bodies:	5 hours

Regulations related to the use of drug, gene and cell-based products, Regulatory governance in the US, Europe and Asia

Module:3	Good laboratory practices(GLPs) and Good Manufacturing practices (GMPs):	7 hours

Biosafety levels, quality assurance, SOPs and documentations, GLPs associated with drug, gene and cellbased products, Facility organization, personnel training, quality assurance, documentations, manufacturing and validation, GMP associated with drug, gene and cell-based products

Module:4	Translational research:	8 hours

Bench to bedside, T1, T2, T3 and T4 phases, Treatment approaches using Imaging tools, Nanotechnology, Small molecules (Chaperones), Gene-based therapies, Innovative services and Informatics tools; Health Street model.

Module:5	Human Based Systems for Translational Research:	8 hours

Translational Research in Pharmacology and Toxicology Using Precision-Cut Tissue Slices, Modelling the Human Respiratory System: Approaches for in vitro Safety Testing and Drug Discovery, Survival analysis, "Body-on-a-Chip' Technology and Supporting Microfluidics, Human micro-dosing.		
Module:6	**Preclinical trials and Clinical trials:**	**7 hours**
Small and large animal models, animal facility clearance, care and maintenance of animals, Clinical trials- Phase – I, II, III and IV clinical trials, Investigational new drug/device applications.		
Module:7	**Risk assessment, mitigation and emerging topics**	**5 hours**
Safety risk and adverse reactions to drug, gene and cell-based products; Consequences and mitigation, Drug scenario in India, Rational use of medicine in India. Pharmacovigilance – challenges in India, Standard treatment guidelines and essential medicine list, Invited talks by industry experts, policy makers and medical practitioners.		
Module:8	**Contemporary issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Clinical and Translational Science: Principles of Human Research, 2nd Edition (2016). Edited by David Robertson, Gordon H. Williams.

Reference Books

1.	Good Manufacturing Practices for Pharmaceuticals, 6th edition (2016), edited by Joseph D. Nally.
2.	Various WHO guidelines and various e-reference material from regulatory authorities and scientific bodies
	Mode of Evaluation: Continuous assessment and Final Assessment test.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST6004	Forensic Science and Technology	2	0	0	4	3
Pre-requisite		Syllabus version				
		v.1				

Course Objectives:

1. Know and explain the functioning of national and international legal systems
2. Identify the steps to be taken during any investigations
3. Familiarise the students with available technology, shortage, and improvements in evidence analysis. Thus simplify the products or processes ultimately aimed at speedy and in cost effective manner
4. Interpret and judge different analytical techniques to be used during evidence analysis5.
5. Compile the databases for qualitative and qualitative analysis, and for the prediction during the investigations

Expected Course Outcome:

1.Having a clear outline about the subject related concepts and of contemporary issues
2. Develop an ability to be socially intelligent, with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)
3. Utilizing computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning)
4. Perceived with the problem solving ability, thereby solving the individual and social problems
5. Building a Virtual Collaborating ability
6. Combining the critical thinking and innovative skills

Module:1	Introduction to Forensic Science	5 hours

History and Significance, Experts involved and procedures in crime scene investigative, Forensic laboratories: National and Global laboratories, Body farms: Recent advances.

Module 2	Crime Scene Investigation, and Instrumentation:	4 hours

Evidences: Physical Evidence, collection protocols, Documentation, Chain of Custody, Instrumentation in Forensic Analysis.

Module:3	Forensic Fingerprinting	6 hours

Principle, Types, Fingerprint lifting techniques, Modus Operandi Sheet preparation**,** Fingerprint Recorders: Biometric system in detecting individual variation, Optical, Capacitance-based and other types of fingerprint recorders

Module:4	Impression Evidences, Documents, and other Evidences in Forensic Analysis	6 hours

Impression based evidence: Principle, Tool markings, Tire, Footwear markings and associated databases, Hand writing analysis, Question documents, Polymers and Fiber.

Module:5	Forensic ballistic procedures	5 hours

Types, application, procedures: internal, external and terminal ballistics, and identification of firearms, databases in ballistic analysis.

Module:6	Serology and Toxicology in Forensic	6 hours

	Evaluation	
Serological analysis (blood, saliva, semen etc), Blood Splatter- Origin of impact study, Abusive Drug types, CSA- schedules, Poisons and analysis, Pathology and DNA fingerprinting in Forensics- Time of death analysis; Entomology and pathology in death analysis, Bite-mark analysis, Forensic Medicine**,** DNA fingerprinting: RFLP and PCR (VNTR, STR-CODIS) based profiling		
Module:7	**Forensic Photography and Digital Criminalistics:**	**6 hours**
SLR-camera, Digital camera, CCTV in forensic analysis, Camera techniques for evidence visualization, Forensic Facial Reconstruction, Cyber Forensics: Computer, Mobile phone data analysis, Ethical hacking, drones, remote surveillance in forensic investigations, and Corporate crimes, deception detection tests (DDT): polygraph, narco-analysis and brain-mapping.		
Module:8	**Forensic and Legal proceedings in India**	**2 hours**
Legal proceedings in forensics, CSI in India, and Case studies.		
	Total Lecture hours:	**46 hours**

Text Book(s)

1.	Criminalistics: An Introduction to Forensic Science, 11/E, Richard Saferstein, ISBN-10:0133458822 • ISBN-13: 9780133458824, 2015 • Prentice Hall.

Reference Books

1.	Forensic DNA Typing, 2nd Edition, Biology, Technology, and Genetics of STR Markers, J Butler, 2005, Imprint: Academic Press, eBook ISBN: 9780080470610, Print Book ISBN: 9780121479527, Pages: 688
2.	Introduction to Criminalistics: The Foundation of Forensic Science, 2009, by Barry A.J. Fisher, William J. Tilstone, Catherine Woytowicz, Elsevier Academic Press USA, 2009.
3.	Hendry Lee's Crime Scene Handbook, H.C. Lee, T. Palmbach, M.T. Miller (Academic Press), Published: June 2001, ISBN: 978-0-12-440830-2
	Mode of Evaluation: Assignments, Continuous assessment tests and Final assessment test.

Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No.46	Date	24.08.2017

Course code	Course title	L	T	P	J	C
BST6005	Pharmacology and Toxicology	3	0	0	0	3
Pre-requisite		Syllabus version				
		v. 1				

Course Objectives:

1. Enhancing the basic pharmacological principles within the field of pharmacokinetics and -dynamics
2. Compare different classes of receptors which interact with drugs, and describe intracellular transduction mechanisms coupled to some of these receptors
3. Recognize some of the common manifestations of poisonings as they may present clinically

Expected Course Outcome:

1. The students may acquire the knowledge on study of drug and routes of administration
2. Analyse drug distribution between the compartments of the body and understand the factors affecting the pharmacokinetics of drug in its therapeutic regimen.
3. Acquire knowledge on molecular & biochemical aspects of drug actions, receptors, drug receptor interactions, factors modifying drug effects.
4. Appreciate the toxicity caused when chemicals interfere with physiologic functions;
5. Apply their knowledge of toxicology to the methods used to detect and monitor toxicity
6. The students get to know alternate methods / models for assessing toxicity

Module: 1	General Pharmacology and Pharmacokinetics	6 hours

History of Pharmacology. Routes of Drug administration, Absorption, Distribution and Metabolism. Elimination of drugs: Concept of renal clearance and excretion of drugs – biological half – life, area under curve. Bio-availability of drug products.

Module: 2	Pharmacodynamics	6 hours

Introduction, Receptor theory, Enzyme interactions, physico-chemical interactions. Ionic fluxes second messengers and G proteins. Dose-effect relationships of drugs (graded and quantal response) therapeutic index, potency and efficacy competitive and non-competitive antagonists & agonists. Mechanism of action of general anesthetic agents and analgesic. Mechanisms of adverse drug effects.

Module: 3	Design and Development of Drugs	6 hours

a) Drug discovery process: Principles, Techniques and Strategies used in new drug discovery. Regulations for laboratory animal care and ethical requirements. b) Bioassays: Basic principles of bioassays, official bioassays and experimental models
c) Pre-clinical and clinical models employed in the screening of new drugs

Module: 4	Clinical Pharmacology	6 hours

a) Definition and scope of clinical pharmacology, Evaluation of drugs in experimental and clinical trials. b) Drug therapy monitoring and differences in drugs response. b) Patient counseling and interviewing techniques, Improving patient compliance and patient monitoring.

Module: 5	Molecular pharmacology	6 hours

a) Molecular mechanism of drug action: Receptor occupancy and cellular signalling systems such as G-proteins, cyclic nucleotides, calcium and phosphatidyl inositol. Ionic channels and their modulators. b) Endogenous bioactive molecules: Different kinds of endogenous bioactive molecules and its roles (Cytokines, neuropeptides, steroids, nitric oxide, phosphodiestrase enzyme and protein kinase C).

Module: 6	**Toxicology**	**5 hours**
a) History and Exposure routes – Food, Water, Air and Skin. b) Alternative to animal screening procedure. Models of study drug metabolism. Adverse drug reactions and drug interactions.		
Module: 7	**Cytotoxicity**	**5 hours**
a) Molecular mechanisms of Cell death- reactive intermediates and detoxification of radicals. Methods of establishing level of necrosis. Determining covalent binding and LPO. Determination of LD50, ED50, and TD50. b) Genetic toxicity – Mutagenicity, Biological relevance of mutations. Types of mutations – Gene, Structural and Genome mutations. Mutagenicity tests.		
Module: 8	**Metals toxicology**	**5 hours**
a) Metal metabolism and toxicity. Cellular and Molecular Mechanism of Metal toxicity. b) Nutrition and toxicology – Influence of Dietary substance and Nutrients in Xenobiotics. Inhalation toxicology – Deposition of Inhalated Materials (Gases, Vapors & Particles) its metabolism		
	Total Lecture hrs	**45 hours**
Mode : Use of technology in teaching, lecture by industry experts **Evaluation :** Written examinations, Projects and assignments		
Text Books and articles: 1. Humphrey p. Rang. Rang & amp Dale's Pharmacology, 7th edition 2011. 2. Curtis Klaassen, John B. Watkins III. Casarett & Doull's essentials of Toxicology, 3rd Edition, 2015.		
Reference books and articles: 1. Lynn Wecker, Lynn Crespo, Genorge Dunaway, Carl Faingold and Stephanie Watts. Brody's Human Plarmacology, Elsevier 5th Edition 2010. 2. Stan Bardal, Jason Waechter, and Doug Martin. Applied Pharmacology. Elsevier 2011. 3. Ernest Hodgson. A Textbook of Modern Toxicology, 4th Edition 2011. 4. Laurence Brunton, Bruce A. Chabner, Bjorn Knollman. Goodman and Gilman's the Pharmacological Basis of Therapeutics, 12th Edtion, McGraw Hill Education (2011) 5. R.S. Satoskar, S.D.Bhandarkar, Nirmala N. Rege, R.R. Satoskar. Pharmacology and Pharmacotherapeutics 20th Revised Edition, Popular Prakashan (P) Ltd (2014) 6. Bertram G. Katzung, Susan B. Masters, Anthony J. Trevor, Basic and Clinical pharmacology 12th edition, McGraw-Hill Medical (2015) 1. Karen E. Stine. Thomas M. Brown. Principles of Toxicology. 3rd Edition CRC Press (2015)		
Recommended by Board of Studies	03.08.2017	
Approved by Academic Council	No.46	24.08.2017

Course code	Course title	L	T	P	J	C
BST6006	Medical Informatics	2	0	0	4	3
Pre-requisite		Syllabus version				
		v.1				

Course Objectives:

1.Facilitate understanding of current issues and developments in the medical field, provide basic skills for managing information
2.To identify opportunities for the application of informatics principles to medical health research and practice
3. Distinguish the various types of health care information including data, source, knowledge and importance of technology and standards.

Expected Course Outcome:

1. Interpret network systems and their application in medical laboratories;
2. Identify the issues surrounding the security of digital information especially as it relates to patient healthcare information;
3. Examine the application of image analysis software and expert systems/decision support systems in the healthcare and medical research environment;
4. Perform basic software functions using word processing, spread sheet, database, presentation and image analysis programs, and
5. Demonstrate the need for standards in the formatting, distribution and storage of medical information.

Module:1	Overview of Medical Informatics	4 hours

The Goals of Medical Informatics, Why computers in healthcare? Systems Design Considerations for the Clinical User.

Module 2	Electronic Health Records:	4 hours

Integrated Practice Management Systems, The Paper-based Medical Record, Current Use of HER in Healthcare Settings, Vist A (VA EHR System)

Module:3	Clinical support Systems:	4 hours

Hospital Information Systems, Clinical Information Systems, Laboratory Information Systems, Pharmacy Information Systems.

Module:4	Introduction to Medical Networks:	4 hours

Introduction to Medical Network Design & Development and its applications.

Module:5	Emergence of Medical Informatics:	4 hours

Medical informatics as a Discipline, Predominant Architectures and Practices.

Module:6	Informatics Issues in Virtual Healthcare, Telemedicine:	4 hours

e-Health, Virtual Healthcare Delivery System, Issues in Telemedicine: Real-time, Store-and- forward

Module:7	**Medical Informatics, Clinical Decision Making and recent technologies**	**4 hours**
Measuring Quality and Outcomes, Standards and Quality Improvement and Evidence-Based Medicine. Integrating the personal health record with mobile technology, implantable chips, personalized medicine, genome based medical care.		
Module:8	**Contemporary issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.Bemmel, J.van; Musen, M.A. Handbook of Medical Informatics 1st ed. 2014.

2. Computers In Medicine, Tata McGraw Hill, 2015.

3. Davidson, P., Best Practice Series: Healthcare Information Systems, Auerbach Publications, 2015

4. Medical Informatics. A Primer: Mohan Bansal, Tata McGraw Hill, 2013

5. Slack, Cyber medicine: How Computing Empowers Doctors and Patients for Better Health Care, Jossey-Bass, Revised 2011

6. Ellis, Technology and the Future of Health Care, Preparing for the Next 30 Years, Jossey-Bass, 2016

Reference Books

1. Bryan Bergeron, Bioinformatics Computing (2012), a complete guide to Bioinformatics for Molecular biologists and life scientist.
2. Medical Informatics. A Primer: Mohan Bansal, Tata McGraw Hill, 2013

Mode of Evaluation: Continuous assessment and Final Assessment test

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No.46	Date	24-08-17

Course code	Course title	L	T	P	J	C
BST6007	Nutraceuticals	2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
		v.1				

Course Objectives:

1. Build knowledge on the function of nutraceutical compounds to manage various diseases
2. Deduct the marketing potential of nutraceutical compounds related to health management
3. Identify various types of nutraceuticals and molecular mechanism behind the choice of a specific nutraceutical compound.

Expected Course Outcome:

1. Understand the functional aspect of nutraceutical compounds
2. Extend the importance of nutraceuticals in relation to health
3. Discuss the various processing methods of nutraceuticals
4. Select various sources of nutraceuticals from plant, animal, microbes, and marine origin
5. Predict the diverse nutraceutical compounds involved in disease prevention
6. Decide the safety issues, regulatory policies, health claims, and clinical trials in using nutraceuticals

Module:1	Introduction to nutraceuticals and functional foods:	3 hours

Definition, concept of nutraceuticals; classification of nutraceuticals, dietary supplements, fortified foods, functional foods; scope involved in the industry- Indian and global scenario.

Module 2	Importance of nutraceuticals:	4 hours

Food pyramid, nutritional assessment, recommended dietary intake, glycemic index, basal metabolic rate, nutraceuticals in fruits, vegetables and grains with health benefits, nutraceuticals in relation to sports and exercise. Emerging concepts in nutraceuticals: Life style changes - Nutraceutical transition and its implications. Enhancing quality and bioavailability of nutraceuticals. Nutrigenomics.

Module:3	Extraction, analysis, physiology, processing of nutraceuticals:	4 hours

Nutraceutical extraction and isolation; nutraceutical analysis; absorption, disposition, metabolism, and elimination of nutraceuticals.

Module:4	Nutraceuticals of plant and animal origin:	6 hours

Phytochemicals as nutraceuticals- sources and applications in preventive medicine; animal metabolites sources and applications in preventive medicine; protein and peptide- based nutraceuticals, lipid- based nutraceuticals

Module:5	Microbial and marine nutraceuticals:	4 hours

Concept, applications of prebiotics and probiotics as nutraceutical agents, microbial nutraceuticals and their applications, marine nutraceuticals and their applications.

Module:6	Nutraceuticals in disease prevention:	4 hours

Nutraceuticals for- cardiovascular health, HIV and cancer risk reduction, bone and joint health,

diabetes, hypertension, hypercholesterolemia, immune system, oxidative stress, cognitive function, anti-ageing, maternal and infant health, gut health, reproductive health.		
Module:7	**Marketing, regulation, health claims and clinical trials and Emerging concepts in nutraceuticals**	**3 hours**
Assessment of safety and efficacy of functional foods and ingredients, regulatory issues and health claims, use of animal models and pre-clinical and clinical trials involved. Life style changes – Nutraceutical transition and its implications. Enhancing quality and bioavailability of nutraceuticals. Nutrigenomics.		
Module:8	**Contemporary Issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Debasis Bagchi, Harry G. Preuss, Anand Swaroop. Nutraceuticals and Functional Foods in Human Health and Disease Prevention. 2015. CRC Press.

Reference Books

1.	Yoshinori Mine, Eunice Li-Chan, and Bo Jiang. Bioactive Proteins and Peptides as Functional Foods and Nutraceuticals. 2010. Blackwell Publishing Ltd.
	Mode of Evaluation: **Continuous Assessment Tests 1, 2; Quiz 1, 2; Assignment, Term End Examination**

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST6008	Marine Biotechnology	3	0	0	0	3

Pre-requisite	Nil	Syllabus version
		v. 1.1

Course Objectives:

1. Explain the scope and challenges in the field of marine biotechnology.
2.Build better knowledge about marine ecosystems, biodiversity & taxonomy, tools and techniques used and role of marine organisms in biogeochemical cycles.
3. Realize the biotechnological importance and to explore the potential of marine organisms for human betterment.
4. Develop the students' skills to take up employment, to pursue research as well as to become an entrepreneur in marine biotechnology field.

Expected Course Outcome:

1. Develop knowledge about the importance, opportunities and challenges in the field of marine biotechnology
2. Compare about the various marine ecosystems, their characteristics and biodiversity
3. Implementing various tools and techniques used for sample collection, isolation of micro and macro organisms and to study their taxonomy.
4. Analyze the importance and role of marine organisms in biogeochemical cycles and global climate change
5. Discuss and elaborate about various marine pathogenic microbes and their transmission to land
6. Retrieving knowledge on process of drug discovery from marine organisms and various assays and techniques related to it
7. Utilize marine organisms for food, fuel, agriculture, environment, cosmetics, industrial feedstock etc.
8. Demonstrate the various techniques and tools necessary for studying marine microbial diversity and its applications

Module:1	**Scope and Challenges in marine biotechnology**:	8 hours

Global and Indian scenario; Demand for marine bio products; market value; marine bio-product based industries; marine bio-economy; Marine socio-economics; Entrepreneurship; International and Indian policies; Marine biotechnology parks in various states; R&D institutions, centres and consultation services.

Module:2	**Marine Ecology:**	5 hours

Benthic and Pelagic Zone; Photic, dysphotic and aphotic zones- importance and their significance. Biological divisions of the sea- estuaries and backwaters, lagoons, mangroves, coastal waters, inshore, offshore, deep sea/oceanic zone.

Module:3	**Biological Resources and taxonomy:**	5 hours

Sampling, cultivation and taxonomy of organisms. Metagenomics. Flora, Fauna, Bacteria, fungi, algae and archaea. Extremophilic microorganisms; Fisheries and other aquatic potential.

Module:4	**Marine Biogeochemical cycles:**	5 hours

Role of marine organisms in carbon, nitrogen, phosphorous and sulphur cycles		
Module:5	**Marine microbial pathogens:**	**5 hours**
Microbial pathogens in marine environment - diversity, sources and detection of pathogens in recreational water, impact of harmful algal blooms, microbial pathogens of seafood.		
Module:6	**Marine Pharmacology: marine products:**	**6 hours**
Marine derived drugs in preclinical and clinical trials- FDA and EMEA approved marine derived drugs, their use and mode of action. Screening of drugs High-throughput Screening Assays (HTS). Bioassays- Enzyme assays, cytotoxicity assay; antimicrobial assay; DNA laddering assay; Apoptosis assays.		
Module:7	**Marine Bioprospecting:**	**6 hours**
Marine organisms for Biofuels and bioenergy, Bioremediation, Biofouling, Biosurfactants. Marine natural products as cosmetics-cosmeceuticals, algotherapy; Thalassotherapy; Enzymes; food, supplement, nutrition and energy drinks. Marine algae as fish feed, manure and fertilizers.		
Module:8	**Recent Developments in marine and Aquatic Biotechnology**	**5 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Frontiers in Marine Biotechnology [Hardcover] Peter Proksch and Werner E.G. Müller (Eds.) Taylor & Francis; 1 edition (2006)
Reference Books	
1.	Aquaculture Microbiology and Biotechnology, Volume Two. Didier Montet and, Ramesh C. Ray (Eds.) Science Publishers; 1 edition (2011).
2.	Introduction to Marine Biology. George Karleskint, Richard Turner, and James Small (Eds.) Brooks Cole; 3 edition (2009).
3.	Bioactive Marine Natural Products [Paperback]. Dewan S. Bhakuni and, D.S. Rawat (Eds.)) Springer; Softcover, (2010)
4.	John Paul, Marine Microbiology, Elsevier. (1999)
5.	Munn and Munn,. Marine Microbiology: Ecology and Applications. BIOS, Scientific Publisher, (1996)
6.	Rheinheimer, G., Aquatic Microbiology-an Ecological Approach, Blackwell Scientific Publications (1980)
	Mode of Evaluation: Continuous assessment and Final Assessment test

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST6009	Nanobiotechnology	2	0	0	4	3
Pre-requisite	Nil			Syllabus		
				v. 1		

Course Objectives

1. To motivate students grasp the basics of nanotechnology.
2. Get exposed to potential applications of nanobiotechnology
3. Ability to assimilate existing and new concepts, methodologies and research results and apply them in an academic or industrial research environment.
4. Ability to reflect on ethical and scientific problems related to this field.

Expected Course Outcome:

1. To enable them grasp basic concepts and theories of the subject
2. Implement the application of analytical techniques in examining nanostructures/ particles
3. Outline and tell the scope of bio macromolecules in nanotechnology
4. To enable students appreciate the potential of nano biotechnology in consumer applications and diagnostics
5. To develop necessary foundation for training in research
6. Formulate risk assessment strategies in usage of nanostructures/ particles in various applications.

Module:1	Nanomaterials -biology interface:	4 hours

Advances, development, timelines and overview; nanomaterials in biotechnology: Carbon Nano Tubes (CNTs), Quantum Dots (QDs), metallic nanoparticles.

Module:2	Bio macro molecules in nano biology:	5 hours

Self-assembly of lipids, proteins; static and dynamic self-assembly; DNA based nanostructures/ devices, size distribution.

Module:3	Biogenic and biomimetic nanoparticles:	4 hours

Plant, microbial routes; types, synthetic procedures; magnetosomes; ferritins.

Module:4	Characterization of biologically relevant nanoparticles and structures:	3 hours

Zeta potential; Dynamic light scattering; UV-visible and fluorescence spectroscopy, SERS. FTIR; XRD, EDAX; Microscopy: SEM, TEM, AFM; SPR based imaging; nano secondary ion mass spectrometry (NanoSIMS).

Module:5	Nanotechnology in food and agriculture:	4 hours

Food quality monitoring; adulteration; food packaging; food grade nanomaterials and safety assessment.

Module:6	Nanotechnology in environment:	4 hours

Environmental sensors for monitoring pollutants. Nanomaterials based remediation approaches.

Module:7	**Nanotechnology in health care applications and toxicity effects of nanomaterials:**	**4 hours**
Tissue engineering, targeted drug delivery- nano-diagnostics; evaluation of nanoparticles (NPs) in animal models, cellular uptake.		
Module:8	**Nanomaterials in consumer products:**	**3 hours**
Cosmetics, toothpaste; environmental release. Cellular interaction and fate of nanoparticles in environment.		
" J" COMPONENT:		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	The Nanobiotechnology Handbook, YubingXie,2012, CRC Press, Taylor Francis group
2.	Nanobiotechnology: Concepts, applications and perspectives, eds. CM Niemeyer, CAMirkin, 2005, Wiley-VCH Verlag GmbH & Co., KgaA, Weiheim.
3.	Nanobiotechnology II: More Concepts and Applications, eds. CA Mirkin, CM Niemeyer, 2007, Wiley-VCH Verlag GmbH & Co., KgaA, Weiheim.

Reference Books

1.	Nanotechnology: An introduction to nanostructuring techniques, eds. M Kohler, WFritzsche, Wiley-VCH Verlag GmbH & Co. KgaA, Weiheim.
2.	Relevant articles from Web and recent review articles from peer reviewed scientific journal.
	Mode of Evaluation: Continuous assessment and Final Assessment test

Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No.46	Date	24.08.2017

Course code	Course title	L	T	P	J	C
BST6010	Applied Enzyme Technology	3	0	2	0	4
Pre-requisite	Nil			Syllabus		
						v. 1

Course Objectives:

1. To learn kinetics of enzymatic reactions and to understand its catalysis process
2. To analyse the effects of parameters affecting enzyme kinetics and formulate methods to evaluate enzyme kinetics in homogeneous and heterogeneous systems;
3. To know the technologies of production of industrial enzymes and understand medically important enzymes.

Expected Course Outcome:

1. Demonstrate the understand of the enzyme and its catalysis process
2. Students would be confident in preparing Immobilizing enzymes and understand its kinetics behavior
3. Students are able to say about production of industrial enzymes and understand its application in Industry and other fields.
4. Students can interpret about different kinds of medically important enzymes and how are they diagnosed in the clinical settings.

Module:1	**Introduction and history of Enzymes:**	**5 hours**

Classification of enzyme;Types of enzymes- Constitutive enzyme, induced enzymes, Intracellular and Extracellular enzymes

Module:2	**Enzyme kinetics:**	**7 hours**

Factors affecting rates of enzyme catalyzed reactions, concept of Brigs Haldene Modification on M-M

Module:3	**Classification and kinetics of multi-substrate reactions:**	**6 hours**

Enzyme Inhibition and drug discovery. .

Module:4	**Purification and Characterization:**	**6 hours**

Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes

Module:5	**Enzyme Immobilization:**	**6 hours**

Physical and chemical techniques for enzyme immobilization with examples. Advantages and disadvantages of different immobilization techniques. Effect of solute partition and diffusion on the kinetics of immobilized enzymes.

Module:6	**Applications of immobilized enzymes:**	**5 hours**

Enzyme reactors - Continuous flow reactors, Packed bed reactors, Continuous flow stirred tank reactors, Fluidized bed reactors

Module:7	**Enzymes in medicine:**	**6 hours**

Enzymes in diagnosis - GOD, Urease, LDH, ALP, CK, SGPT & OT. Enzyme in therapy- α - amylase, bromalain, rennin, papain, catalase, streptokinase and urokinase. Application of enzymes in food, pharmaceutical and other industries; Enzymes for analytical and diagnostic applications

Module:8	Enzyme Biosensors	5 hours
Types of Biosensors; design of enzymeelectrodes and their application as biosensors in industry, healthcare and environment. Novel enzymes from natural resources, Modified enzymes- enzyme engineering, semisynthetic enzymes, abzymes and synzymes		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Enzymes by Palmer Horwood Publishing Series. 2001
2.	Fundamentals of Enzymology by Price and Stevens Oxford University Press. 2002

Reference Books	
1	Biocatalysts and enzyme technology, Klaus Buchholz, Volker Kasche, Uwe Theo Bornscheuer, Published by Wiley-VCH, 2005.
2.	Wiseman, A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication,2010
3.	Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer Horwood Publishing House, Chichester, England, 2001.
4.	Practical enzymology. By Hans Bisswanger. Wiley Publication. 2nd Edition, 2011

List of Challenging Experiments (Indicative)	
1.	.Extraction of acid phosphatase from sweet
2	To study time course of the reaction catalyzed by alkaline phosphatase (EC 3.1.3.1)
3	To examine the effect of enzyme concentration on the rate of an enzyme catalyzed reaction
4	To examine the effect of pH on activity of alkaline phosphatase
5	To study the effect of substrate concentration on activity of ALP and determine the Km and Vmax of the reaction
6	To determine temperature optima for Alkaline phosphatase
7	The hydrolysis of sucrose by yeast β-Fructofuranosidase
8	Estimation of lipase activity
9	Determination of LDH in liver tissues
10	Determination of SOD and Catalase in hemolysate
	Total Laboratory Hours:15

Mode of Evaluation: Continuous assessment and Final Assessment test.

Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No. 46	Date	24-08-2017

BST6011	Course title	L	T	P	J	C
	Metabolic Engineering	3	0	0	0	3
Pre-requisite	NIL	Syllabus version				
		v.1.1				

Course Objectives:

1. To provide a basic knowledge about strategic manipulation of metabolism
2. To provide quantitative perspective of metabolic regulations and developing metabolic models
3. To demonstrate metabolic network construction and reconstruction

Expected Course Outcome:

1. Apply knowledge of mathematics, science, and engineering
2. Integrate modern biology with engineering principles
3. Identify, formulate, and solve biochemical engineering problems
4. Analyze flux to identify nodal control
5. Model enzyme kinetics and metabolic fluxes along with control
6. Design metabolic models to represent metabolic networks in single cells and at the organ level

Module:1	Basics of metabolic engineering	6 hours

Cellular metabolism, order and molecularity of the reactions, stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients

Module 2	Metabolic pathway analysis and regulation	8 hours

Metabolic pathways databases, Overview of enzyme activity and concentration; global control regulation; Limiting accumulation of end-products

Module:3	Basics of metabolic flux analysis	7 hours

Concept of Nodal points, Linear and Branched pathways, Determined, over determined and undetermined systems; sensitivity analysis, Fiatflux software for MFA

Module:4	Methods for Metabolic Flux and Control analysis	6 hours

Direct flux determination, enumeration of metabolite isotopomers (NMR and MS), carbon metabolite balances, Flux control coefficients

Module:5	Methods for Metabolic control analysis	6 hours

Determination of flux control coefficients, concentration control coefficients

Module:6	Metabolic design:	5 hours

Synthetic Biology, Design of Genetic circuits, Recent developments in Metabolic design, Constraint based Genome scale models

Module:7	Metabolic engineering in Practice:	5 hours

Randomized and targeted strain development strategies, Applications of Metabolic Control Analysis		
Module:8	Contemporary issues:	**2 hours**
Lecture by Industrial Expert		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	George Stephanopoulos, Aristos A Aristidou, Jens Nielsen (2005) Metabolic Engineering - Principles and Methodologies. Academic Press Inc.
2.	H. Sahm, C. Wandrey, Metabolic Engineering, 2014, Springer Berlin Heidelberg.
Reference Books	
1.	S. Sen, L. Datta and S. Mitra (2018) Machine Learning and IoT: A Biological Perspective, CRC Press, Taylor and Francis Group
2.	Michael E Wall, (2012) Quantitative Biology: From Molecular to Cellular Systems, Chapman & Hall.
3.	Arul Jayaraman, Juergen Hahn (2009) Methods in Bioengineering: Systems Analysis of Biological Networks, Artech House Publishers.
	Mode of Evaluation: Continuous assessment (Digital assignments, Online quiz, Examination)

Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No.46	Date	24.08.2017

Course code	Course title	L	T	P	J	C
BST6012	Plant Biotechnology	2	0	2	4	4

Pre-requisite	Nil	Syllabus version
		v. 1

Course Objectives:

1. To equip students with knowledge on basic tools and principles of plant biotechnology for crops resources research and development
2. To introduce students to practical applications of plant biotechnology in agriculture
3. Understanding of biotechnological processes has also applicative value in pharmaceutical and food industry, in agriculture and in ecology

Expected Course Outcome:

1. Execute the basics of the physiological and molecular processes that occur during plant growth
2. Students will acquire a comprehensive knowledge on plant tissue culture, methods of gene identification, engineering of the identified genes and genetic manipulation of plants and in the field of Plant biotechnology.
3. Learn the various components involved in developing transgenic plants
4. Compare and apply molecular marker technology in plant breeding
5. In addition, this course will provide an overview of plant biotechnology in applications such as producing drugs and vaccines for pharmaceutical industry and creating GM crops for better human nutrition.
6. Practice tissue culture techniques and get employed in a plant biotechnology based industry.

Module:1	Introduction to plant biotechnology:	2 hours

Basic concepts and history of biotechnology; need, scope, outline of plant biotechnology.

Module:2	Plant tissue culture:	2 hours

Media and culture conditions- basal media, growth regulators; micro propagation; culture types and their uses- callus and somatic embryo culture, cell suspension cultures, pollen/anther culture, protoplast culture, meristem culture; regeneration methods of plants in culture-organogenesis, somatic embryogenesis; hairy root cultures, artificial seeds.

Module:3	Production of transgenic plants:	4 hours

Plant genetic transformation, modes of gene delivery in plants- particle bombardment, electroporation, microinjection, *Agrobacterium* mediated gene transfer, Ti and Ri plasmids, screening and selection of transformants, marker free transgenics, Bt crops, golden rice.

Module:4	Molecular markers and mapping techniques in plant improvement:	5 hours

RFLP maps, RAPD markers, STS, microsatellite, SCAR, SSCP, QTL mapping, high throughput genotyping, synteny mapping, plant DNA barcoding, gene pyramiding, RNAi, CRISPR-Cas and microRNA systems in plant biotechnology.

Module:5	Transgenics in crop improvement:	5 hours

Production of high yielding varieties, resistance to herbicides, resistance to pests and diseases, manipulating male sterility, tolerance to abiotic stresses, manipulating food quality- prolonging shelf life, improved nutritional quality.		
Module:6	**Applications of transgenic plants in industry:**	**5 hours**
Production of plant secondary metabolites, metabolic engineering, plants as factories for production of industrial enzymes, biodegradable plastics, biopharming and nutraceuticals, edible vaccines, plantibodies, peptide expression in plants, biofuels		
Module:7	**Impact of plant biotechnology:**	**5 hours**
Risk factors and regulations related to genetically modified crops (GMC), Intellectual property rights of GM crops, Transgenic plants – International and National status, biohazards of rDNA technology.		
Module:8	**Contemporary issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Roberta Smith. Plant Tissue Culture: Techniques and Experiments. Academic Press, 2012
2.	Singh B.D. Plant Biotechnology, Kalyani Publishers, 2014.
Reference Books	
1.	Kole, C., Michler, C., Abbott, A.G., Hall, T.C. (Eds.) Transgenic Crop Plants: Volume 1: Principles and Development. Springer. 2010.
2.	Kole, C., Michler, C., Abbott, A.G., Hall, T.C. (Eds.) Transgenic Crop Plants: Volume 2: Utilization and Biosafety. Springer. 2010.

List of Challenging Experiments (Indicative)		
1.	Study on the design and structure of a plant tissue culture laboratory and greenhouse	2 hours
2.	Aseptic techniques - wet sterilization, filter sterilization, irradiation, chemical sterilization and laminar airflow chamber	2 hours
3.	Preparation of stock solutions of basal medium, organic supplements and plant growth regulators; preparation of plant tissue culture media	2 hours
4.	Surface sterilization of explants, inoculation and micro propagation of plants	3 hours
5.	Zygotic embryo culture, leaf bit, root bit, shoot tip, nodal and microspore culture	3 hours
6.	Sub culturing and development of friable calli	2 hours
7.	Preparing a suspension culture from friable calli and plotting the growth curve	3 hours
8.	Protoplast isolation and fusion	3 hours
9.	Direct/indirect organogenesis; Shooting and rooting	3 hours
10.	Isolation of plant genomic DNA	3 hours

11.	Co-culturing of explant and callus; floral dip with Agrobacterium tumefaciens; studying carrot tissue proliferation on transformation with T DNA; screening of transformed tissue	2 hours
12.	Hardening techniques; growing in coco peat trays; secondary hardening	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Continuous assessment (Digital assignments, Online quiz, Examination)

Recommended by Board of Studies	03.08.2014		
Approved by Academic Council	No.46	Date	24.08.2014

Course code	Course title	L	T	P	J	C
BST6013	Bioremediation	2	0	0	4	3

Pre-requisite	Nil	Syllabus version
		v. 1

Course Objectives:

1. Relate the various aspects of pollution sources and microbial resistance to understand degradation pathways
2. Summarize the microbial and non-microbial degradation processes
3. Build knowledge on the applied aspects of bioremediation

Expected Course Outcome:

1. Defining the sources of pollution and EM technology.
2. Relating the knowledge on microbial resistance towards toxic compounds and degradation pathway.
3. Selecting the various remediation technologies for the bioremoval of toxic compounds..
4. Analyzing the knowledge in the fungal and algal biodegradation.
5. Inferring the importance of plant microbe interaction in bioremediation through metabolomics and importance of GMO's and bioreactors in bioremediation
6. Designing a novel study with the knowledge and nuances gained from the above modules

Module:1	Basics and terminologies in bioremediation:	4 hours

Sources of pollution, Physico-chemical parameters of the pollutants, Screening for effective microbe for the bioremoval of toxic compounds, Qualitative and Quantitative analysis of the toxic compounds from polluted site

Module:2	Metabolism of Biodegradation:	6 hours

Microbial and plant resistance towards toxic compounds, metal microbe interactions, Detection of candidate genes and enzymes involved in the process of degradation – Aromatic and aliphatic compounds, Application of KEGG pathway in bioremediation

Module:3	Bioremediation:	6 hours

Bioremoval of toxic compounds like heavy metals, pesticides, hydrocarbons and other xenobiotic compounds, *In-situ* – Bioaugmentation, Bioventing and others technologies, *Ex-situ* – solid waste management (Landfarming, composting and Biopiles).

Module:4	Non-bacterial Biodegradation:	3 hours

Fungal Biodegradation and Phycodegradation, Biodegradation in biofuel production, Co_2 Sequestration

Module:5	Plant microbe interactions in biodegradation:	3 hours

Phyto remediation and its types, rhizoremediation strategy and processes, case study in the removal of heavy metals and other toxic compounds (Chernobyl accident) onsite

Module:6	Bioreactors and Genetically Modified Organisms (GMO):	3 hours

Aerobic and anoxic type bioreactor for biodegradation - solid, liquid and air (slurry, batch and continuous processes), Application of GMO's in Bioremediation		
Module:7	**Metabolomics studies:**	**3 hours**
Superbugs as super savers, engineered enzymes, products and biosensors involved in biodegradation, Metabolomics in bioremediation, Recent advances in bioremediation.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Ralph Mitchell and Ji-Dong Gu. 2010. Environmental Microbiology, 2nd edition, Wiley and Blackwell, Inc. .

Reference Books

1.	Ralph Mitchell and Ji-Dong Gu. 2010. Environmental Microbiology, 2nd edition, Wiley and Blackwell, Inc.
2.	M. N. V. Prasad, 2016. Bioremediation and Bioeconomy, Elsevier.

Mode of Evaluation :Continuous assessment (Digital assignments, Online quiz, Examination)

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST6014	Genomics and Proteomics	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v. 1				

Course Objectives:

This course aims to provide you with the knowledge and research skills associated with functional genomics and proteomics.

Expected Course Outcome:

1. At the end of the course student should be able to discuss about the Genome biology.
2. The student would be able to apply the tools available in the open source to the specific research problems and projects
3. The students can interpret the data obtained from high through studies.
4. Communicate on the recent developments in the genomics and proteomics, and its application in human disease biology.
5. Discuss about the emerging areas of biology that use the basics of Genomics and Proteomics.
6.Work effectively in interdisciplinary teams

Module:1	Genome overview:	7 hours

Structure and organization of genomes, Genome size, Sequence complexity, Modern Genome Sequencing, Genome mapping, Human Genome project, Chromosome landmarks, Genetic variations, Physical maps

Module:2	Genomics:	6 hours

Gene identification and annotation, Functional and comparative genomics, DNA and disease association, Epigenomics

Module:3	Proteome overview:	7 hours

Definition, Worm proteome, Fly proteome, Strategies for protein identification, Protein sequencing, Peptide Mass Fingerprinting

Module:4	Proteomics:	5 hours

Protein Engineering, Protein Chip technology, Cancer Proteomics, Antibody microarrays, Protein modifications

Module:5	Bridging Genomics and Proteomics:	5 hours

Domain architecture, Sequence-structure mapping, Protein folding, forces and interactions, Regulomes, Stimulomes and Phenome, Secretome

Module:6	Applications I:	5 hours

Metagenomics, Toxicogenomics, Gene therapy, Glycobiology

Module:7	Applications II:	5 hours

Proteomics in plant genetics and breeding, Diagnostic Proteomics, New approaches to therapy, Future of the field

Module:8	Contemporary issues:	5 hours

	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	S.B. Primrose and R.M. Twyman, 2013.Principles of Genome analysis and Genomics. 7th edition, Blackwell publishing.
2.	Principles of Proteomics. R. Tymann, 2nd edition, Garland Science, 2013
Reference Books	
1.	**Cancer Genomics and Proteomics:** Methods and Protocols, Narendra Wajapeyee, 2014, Springer New York.

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
BST6015	Signal Transduction	2	0	0	0	2
Pre-requisite		Syllabus version				
		v.1				

Course Objectives:

1. Explain the process of disease progression in terms of cellular signalling
2. Discuss the aetiology, available diagnostics, and treatment methodologies for varying disorders
3. Develop the products or processes which are ultimately aimed in interfering and thus treating the disease cost effectively
4. Distinguish the utility of different analytical techniques that can be used to study the outcome of the disease
5. Device Omics based methodologies for qualitative and qualitative analysis for the prediction and application while treatment

Expected Course Outcome:

1. Building the ability to be socially intelligent with good SIQ (Social Intelligence Quotient) and EQ (Emotional Quotient)
2. Having a clear understanding of the subject related concepts and of contemporary issues
3. Developing problem solving ability both for solving personal and social issues
4. Adopting critical thinking and innovative skills
5. Solving problem by computational thinking (Ability to translate vast data in to abstract concepts, and to understand database reasoning)

Module:1	**Introduction to Signal Transduction**	**2 hours**
Signals and receptors, Importance and overview of signal transduction		
Module 2	**General principles and mechanisms**	**2 hours**
Principles and mechanisms of various signaling molecules, second messengers, signaling networks information flow, computation and decision making		
Module:3	**Signaling Receptors**	**3 hours**
G-protein and GPCR, receptor tyrosine kinases and activation of Ras, TGFβ, cytokine receptors and JAK/STAT pathway, calcium signalling.		
Module:4	**Signaling Pathways**	**5 hours**
MAP Kinase, PI3K-PKB/Akt pathway, mTOR signalingCyclic AMP pathway, Wntsignaling, Hedgehog signaling, Notch signaling.		
Module:5	**Signaling processes:**	**5 hours**
Toll-Like receptor signaling, immunoreceptor signaling, signaling by nuclear receptors, Hippo pathway, signaling pathways that control cell proliferation, signaling pathways that regulate cell division, signaling in control of cell growth and metabolism.		
Module:6	**Signaling Mechanisms:**	**5 hours**
Signaling networks that regulate cell migration, signaling pathways in cell polarity, cell fate and embryonic patterning, signaling by sensory receptors, synaptic signaling in learning and memory, signaling in muscle contraction.		
Module:7	**Signaling in diseases:**	**5 hours**

Cell signaling and stress responses, signaling in innate immunity and inflammation signal transduction in cancer, signal transduction in diabetes, obesity, cardiovascular system		
Module:8	**Advanced techniques to visualize the signaling molecules**	**3 hours**
Cellsignaling assays, imaging techniques, FRET, confocal, flow cytometry, fluorescent tags, single-molecule tracking		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	1. Signal Transduction: Principles, Pathways, and Processes (2014). Lewis Cantley, Tony Hunter, Richard Sever, Jeremy Thorner. Cold Spring Harbor Laboratory Press, NY, USA.
Reference Books	
1.	Signal Transduction. Third Edition (2016). Ijsbrand M. Kramer. Academic Press, USA.
	Mode of Evaluation: Use of technology in teaching, lecture by industry experts, Written examinations, Projects and assignments

Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No.46	Date	24.08.2017

Course code	Course title	L	T	P	J	C
BST6016	Cellular and Molecular Biophysics	3	0	0	4	4
Pre-requisite	Nil	Syllabus version				
		v.1				

Course Objectives:

1. Develop knowledge on various single molecule biophysical techniques
2. Discuss biophysics of the neural system, and radioactivity
3. Explain X-ray crystallography, NMR, and other biophysical techniques and their applications.

Expected Course Outcome:

1. Determine the molecular interactions, thermodynamics, protein folding.
2. Explain the principle and applications of various biophysical methods/techniques.
3. Choose the single molecule biophysical techniques.
4. Discuss various aspects of neuro biophysics.
5. Deduct the different types of radioactivity applied in biological system, and their applications.
6. Evaluate the applied aspects of biophysics.

Module:1	Introduction to Biophysics:	6 hours

Molecular orbitals and covalent bonds, molecular interactions in macromolecular structures, thermodynamics, protein folding, simulating macromolecular structure-energy minimization, molecular dynamics.

Module 2	X-ray Crystallography:	7 hours

Symmetries, point groups, space groups, growing crystals of biological molecules, solving macromolecular structures by X-ray diffraction- structure factor, phase problem, molecular replacement, Patterson function, multiple isomorphous replacement, anomalous dispersion, refinement of the structure.

Module:3	Nuclear Magnetic Resonance Spectroscopy:	5 hours

Spin-spin interaction, relaxation and NOE, measuring the spectrum, one-dimensional NMR of macromolecules, 2D-FT NMR.

Module:4	Principles and applications of other biophysical techniques:	6 hours

Dynamic light scattering, small angle X-ray scattering (SAXS), Raman scattering, circular dichroism, isothermal titration calorimetry (ITC), differential scanning calorimetry (DSC), surface plasmon resonance (SPR)

Module:5	Single molecule biophysics:	8 hours

Why study single molecules-Applications-Interferometric scattering microscopy (iSCAT), FIONA- Fluorescence Imaging at One Nanometre Accuracy, TIRFM-Total Internal Reflection Fluorescence Microscopy, FRET- Forster Resonance Energy Transfer, Optical Trap/Tweezers, and
Scanning Tunnelling Microscopy (STM).

Module:6	Neuro biophysics:	6 hours

Brain: parts, lobes, functions; Sleep, Human memory- encoding, storage and retrieval, Human memory- forgetting, artificial neural networks: feed forward nets, recurrent networks, unsupervised learning, reinforcement learning, back propagation, applications of neural networks.		
Module:7	**Radiation biophysics:**	**5 hours**
Radiation definition, units; Radioactivity- rate of radioactive decay, measurement of radioactivity, applications of radio isotopes, biological effects of ionizing radiations, Positron Emission Tomography (PET), use of radiation in diagnosis and analysis.		
Module:8	**Contemporary Issues:**	**2 hours**
Industry expert lectures on contemporary issues		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Molecular Biophysics for the Life Sciences (2013). Norma Allewell, Linda Narhi, Ivan Rayment. Springer Publications.
2.	Fundamentals of Biophysics (2014). Andrey Rubin. Wiley Publications.

Reference Books

1.	Biophysics (2010). Vasantha Pattabhi, N. Gautham. Alpha Science Intl Ltd, USA

Mode of Evaluation:

Continuous Assessment Tests 1, 2; Quiz 1, 2; Assignment, Term End Examination

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

UNIVERSITY CORE

BST6099 Masters Thesis		
Pre-requisite	**As per the academic regulations**	**Syllabus version**
		1.0

Course Objectives:

To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation

Expected Course Outcome:

At the end of the course the student will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Design and Conduct experiments
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions
6. Document the results in the form of technical report / presentation

Contents

1.Can be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, correlation and analysis of data, software development, applied research and any other related activities.

2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40th AC	Date	18.03.2016

Course code	Course title	L	T	P	J	C
MSM5001	Biostatistics	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.1				

Course Objectives:

1. Understand the concepts behind collection and presentation of data
2. Understand the measures of central tendency and dispersion along with related analysis
3. Interpret and analyse data using statistical tools and design experiment

Expected Course Outcome:

1. Construct tables and graphs for data presentation
2. Explain measures of central tendency and dispersion along with predicting probability features of experiments
3. Discuss the correlation between different types of data along with related variables.
4. Test hypothesis and carry out related statistical tests including that of significance.
5. Formulate designs for experiments.
6. Analyse and interpret practically, the data acquired in biological experiments, by using statistical methods

Module:1	Descriptive methods	5 hours

Frequency Distribution, Characteristics of a Frequency Distribution, Tabular and Graphical Presentation of Data: Line Graphs, Bar Charts, Histograms

Module:2	Measures of central tendency	5 hours

Arithmetic Mean, Median, Mode, Selection of the Appropriate Measure of Central Tendency, Geometric Mean, Harmonic Mean

Module:3	Measures of dispersion	3 hours

Range, quartile Deviation, Mean Deviation, Variance and Standard Deviation, Skewness and Kurtosis.

Module:4	Probability	3 hours

Probability Definition, Rules for Calculating Probabilities, Normal Distribution

Module:5	Correlation and Regression	

Correlation , Karl Pearson correlation, Rank correlation, regression analysis

Module:6	Data analysis and interpretation	5 hours

Tests of hypothesis, Tests of significance, student' s t- test, Non-parametric test: chi-square test, Goodness of fit, Analysis of variance. F-test

Module:7	Experimental Design	3 hours

Designed Experiments Principles of experimental design, Blocking and Extraneous Variables. Completely Randomized Design, Randomized block design

Module:8	**Contemporary issues:**	**3 hours**
Industrial Expert lecture		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Wayne W. Daniel, Chad L. Cross,2012, 10th edition, Biostatistics: A Foundation for Analysis in the Health Sciences, Wiley Sciences Publisher
Reference Books	
1.	**Gupta S.P., 2010, 5th Edition, Statistical Methods, Sultan chand & Sons.**

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Determination of frequency distribution for raw data for population	2 Hours
2.	Estimation of mean ,median and mode	2 Hours
3.	Estimation of SD	2 Hours
4.	Estimation of variability	2 Hours
5.	Estimation of correlation coefficient	2 Hours
6.	Estimation of regression analysis	2 Hours
7.	Hypotesis testing	2 Hours
8.	Chi-square test	2 Hours
9.	Challenging research problems on t test	2 Hours
10.	Challenging research problems on Estimation of one way ANOVA	2 Hours
11.	Challenging research problems on Estimation of two way ANOVA	2 Hours
12.	Challenging research problems on Designs of experiments	2 Hours
13.	Challenging research problems on Determination of frequency distribution for raw data for population	3 Hours
14.	Challenging research problems on. Estimation of mean ,median and mode	3 Hours
	Total Laboratory Hours	30 hours

Mode of assessment:			
Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course Code	Course title	L	T	P	J	C
RES5001	Research Methodology	1	0	0	4	2
Pre-requisite		Syllabus version				
		v. 1				

Course Objectives:

1. Impart skills to develop a research topic and design
2. Define a purpose statement, a research question or hypothesis, and a research objective
3. Analyze the data and arrive at a valid conclusion
4. Compile and present research findings

Expected Course Outcome:

1. Explain the basic aspects of research and its ethics
2. Outline research problems, their types and objectives
3. Formulate good research designs and carry out statistically relevant sampling
4. Collect, collate, analyze and interpret data systematically.
5. Experiment with animals ethically
6. Make use of literature and other search engines judiciously for research purposes

Module:1	Introduction and Foundation of Research	2 hours

Meaning, Objectives, Motivation, Utility for research. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method –Understanding the language of research.

Module:2	Problem identification and formulation	4 hours

Scientific Research: Problem, Definition, Objectives, Types, Purposes and components of Research problem

Module:3	Research Design	4 hours

Concept and Importance in Research : Features of a good research design, Exploratory Research Design and Descriptive Research Designs

Module:4	Sampling	6 hours

Sampling methods, Merits and Demerits. Observation methods, Sampling Errors (Type I and Type II). Determining size of the sample. Experimental Design: Concept of Independent &Dependent variables.

Module:5	Data analysis and Reporting	6 hours

Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression; Research Reports: Structure, Components, Types and Layout of Research report and articles, Writing and interpreting research results, Figures and Graphs

Module:6	Animal handling	2 hours

Guidelines-animal ethical committee, animal models, various routes of drug administrations, LD_{50}, ED_{50}

Module:7	**Use of encyclopedias and tools in research**	**4 hours**
Research Guides, Handbook, Academic Databases for Biological Science Discipline. Methods to search required information effectively.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Catherine Dawson, Introduction to research methods : a practical guide for anyone undertaking a research project, Oxford : How To Books, Reprint 2010
2.	Julius S. Bendat, Allan G. Piersol, Random Data: Analysis and Measurement Procedures, 4th Edition, ISBN: 978-1-118-21082-6, 640 pages, September 2011
3.	Research in Medical and Biological Sciences, 1st Edition, From Planning and Preparation to Grant Application and Publication, Editos: Petter Laake Haakon Benestad Bjorn Olsen, ISBN: 9780128001547, Academic Press, March 2015
Reference Books	
1.	John Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Fourth Edition (March 14, 2013)

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	03.08.2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course Title	L	T	P	J	C
ENG5003	English for Science and Technology (for MCA & M.Sc., programmes)	0	0	4	0	2
Pre-requisite	Cleared EPT	Syllabus version				
		v. 1.1				

Course Objectives:

1. To enable students communicate effectively in social, academic and professional contexts thereby enhancing their interpersonal, managerial, problem-solving, and presentation skills.
2. To facilitate students develop their listening competency and critically evaluate and review documentaries, talks and speeches.
3. To Assist students read and comprehend News Articles and Scientific Texts; effectively interpret tables and graphs; write and proof-read official correspondences.

Expected Course Outcome:

1. Make effective presentations and display their interpersonal skills in academic and professional contexts.
2. Emerge as good listeners and critically evaluate oral communication.
3. Excel in reading, comprehending and interpreting technical reports, texts and data.
4. Able to write effectively in English and also display their proof-reading abilities.
5. Face real interviews and handle personal and professional conflicts effectively.

Module:1	**Career Goals**	**4 hours**
Short term and long term career goals Activity: SWOT Analysis/ Comprehending speeches		
Module:2	**Interpersonal Skills**	**4 hours**
Interpersonal Communication in/with Groups (Corporate Etiquette: Journey from Campus to corporate) Activity: Role Plays/Mime/Skit		
Module:3	**Listening Skills**	**4 hours**
Listening to Documentary Activity: Critically evaluate/Review a documentary/TED Talk		
Module:4	**Reading Skills**	**4 hours**
Skimming, Scanning, Intensive & Extensive reading Activity: Reading News Papers/Magazines/Scientific Texts		
Module:5	**Report Writing**	**4 hours**
Language and mechanics of writing report Activity: Writing a Report/Mini Project		
Module:6	**Study Skills**	**4 hours**
Summarizing the report Activity: Abstract, Executive Summary, Digital Synopsis		
Module:7	**Interpreting skills**	**4 hours**
Interpret data in tables and graphs Activity: Transcoding		
Module:8	**Editing Skills**	**4 hours**
Proof Reading Sequencing Activity: Editing any given text		
Module:9	**Presentation Skills**	**4 hours**
Oral Presentation using digital tools		

Activity: Oral presentation on the given topic using appropriate non-verbal cues		
Module:10	**Group Discussion**	**4 hours**
Intragroup interaction (avoid, accommodate, compete, compromise, collaborate) Activity: Group discussion on a given topic		
Module:11	**Professional Skills**	**4 hours**
Résumé Writing Activity: Prepare an Electronic Résumé		
Module:12	**Skill-Gap Analysis**	**4 hours**
Tailor your skills to suit the Job needs Activity: Write a SoP for higher Studies/Purpose Statement for job		
Module:13	**Interview Skills**	**4 hours**
Placement/Job Interview Activity: Mock Interview		
Module:14	**Managerial Skills**	**4 hours**
Official Meeting to organize events Activity: Writing Agenda, Minutes of Meeting (video conferencing) and Organizing an event		
Module:15	**Problem Solving Skills**	**4 hours**
Conflict Management & Decision Making Activity: Case analysis of a challenging Scenario		
	Total Lecture hours	**60 hours**

Text Book(s)

1. Kuhnke, E. Communication Essentials For Dummies. (2015). First Edition. John Wiley & Sons.
2. Hewings, M. Advanced Grammar in Use Book with Answers and CD-ROM: A Self-Study Reference and Practice Book for Advanced Learners of English. (2013). Third Edition. Cambridge University Press. UK.

Reference Books

1. Churches, R. Effective Classroom Communication Pocketbook. Management Pocketbooks. (2015). First Edition. USA.
2. Wallwork, A. English for Writing Research Papers. (2016). Second Edition. Springer.
3. Wood, J. T. Communication in Our Lives. (2016). Cengage Learning. Boston. USA.
4. Anderson, C. TED Talks: The Official TED Guide to Public Speaking. (2016). First Edition.Boston. Houghton Mifflin. New. York.
5. Zinsser, William. On writing well. HarperCollins Publishers. 2016. Thirtieth Edition. New York.
6. Tebeaux, Elizabeth, and Sam Dragga. The essentials of Technical Communication. 2015. First Edition Oxford University Press. USA.

Mode of Evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

List of Challenging Experiments (Indicative)

1.	Setting short term and long term goals	2 hours
2.	Mime/Skit/ Activities through VIT Community Radio	6 hours
3.	Critically evaluate / review a documentary/ Activities through VIT Community Radio	4 hours
4.	Mini Project	10 hours
5.	Digital Synopsis	4 hours
6.	Case analysis of a challenging Scenario	4 hours
7.	Intensive & Extensive reading of Scientific Texts	4 hours

8.	Editing any given text	8 hours
9.	Group discussion on a given topic / Activities through VIT Community Radio	8 hours
10.	Prepare a video résumé along with your video introduction and then create a website (in Google Sites/Webly/Wix) showcasing skills and achievements.	10 hours
	Total Laboratory Hours	**60 hours**

Mode of evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities			
Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	24.08.2017

Course code	Course title	L	T	P	J	C
FRE5001	Franicais Fonctionnel	2	0	0	0	2
Pre-requisite		Syllabus version				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. Achieve proficiency in French culture oriented view point.

Expected Course Outcome:

The students will be able to

1. Remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. Create communicative skill effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. Demonstrate a clear understanding of the French culture through the language studied.

Module:1	Saluer, Se présenter, Etablir des contacts	**9 hours**

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes réguliers, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Module:2	**Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.**	**9 hours**

La conjugaison des verbes Pronominaux, La Négation, L'interrogation avec *'Est-ce que ou sans Est-ce que'*.

Module:3	**Situer un objet ou un lieu, Poser des questions**	**9 hours**

L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, La Nationalité du Pays, L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif/ l'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.,

Module:4	**Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.**	**8 hours**

La traduction simple :(français-anglais / anglais –français)

Module:5	**Trouver les questions, Répondre aux questions générales en français.**	**7 hours**

L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés,

Exprimez les phrases données au Masculin ou Féminin, Associez les phrases.			
Module:6	**Comment ecrire un passage**		**9 hours**
Décrivez : La Famille /La Maison, /L'université /Les Loisirs/ La Vie quotidienne etc.			
Module:7	**Comment ecrire un dialogue**		**7 hours**
Dialogue: a) Réserver un billet de train b) Entre deux amis qui se rencontrent au café c) Parmi les membres de la famille d) Entre le client et le médecin			
Module:8	**Invited Talk: Native speakers**		**2 hours**
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Echo-1, Méthode de français, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
2	Echo-1, Cahier d'exercices, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2004.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2004.
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries , Hachette livre 2006.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	26.02.2016		
Approved by Academic Council	No.41	Date	17-06-2016

Course code	Course title	L	T	P	J	C
GER5001	Deutsch für Anfänger	2	0	0	0	2

Pre-requisite	NIL	Syllabus version
		v.1

Course Objectives:

The course gives students the necessary background to:
1.Enable students to read and communicate in German in their day to day life
2.Become industry-ready
3.Make them understand the usage of grammar in the German Language.

Expected Course Outcome:

The students will be able to
1. Create the basics of German language in their day to day life.
2. Understand the conjugation of different forms of regular/irregular verbs.
3. Understand the rule to identify the gender of the Nouns and apply articles appropriately.
4. Apply the German language skill in writing corresponding letters, E-Mails etc.
5. Create the talent of translating passages from English-German and vice versa and To frame simple dialogues based on given situations.

Module:1	3 hours

Einleitung, Begrüssungsformen, Landeskunde, Alphabet, Personalpronomen, Verb Konjugation, Zahlen (1-100), W-fragen, Aussagesätze, Nomen – Singular und Plural

Lernziel:

Elementares Verständnis von Deutsch, Genus- Artikelwörter

Module:2	3 hours

Konjugation der Verben (regelmässig /unregelmässig) die Monate, die Wochentage, Hobbys, Berufe, Jahreszeiten, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit Sie

Lernziel :

Sätze schreiben, über Hobbys erzählen, über Berufe sprechen usw.

Module:3	4 hours

Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, unbestimmterArtikel), trennnbare verben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlzeiten, Lebensmittel, Getränke

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, über Länder und Sprachen sprechen, über eine Wohnung beschreiben.

Module:4	6 hours

Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch)

Lernziel :

Grammatik – Wortschatz - Übung

Module:5		**5 hours**
Leseverständnis,Mindmap machen,Korrespondenz- Briefe, Postkarten, E-Mail **Lernziel :** Wortschatzbildung und aktiver Sprach gebrauch		
Module:6	.	**3 hours**
Aufsätze : Meine Universität, Das Essen, mein Freund oder meine Freundin, meine Familie, ein Fest in Deutschland usw		
Module:7		**4 hours**
Dialoge: e) Gespräche mit Familienmitgliedern, Am Bahnhof, f) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; g) in einem Hotel - an der Rezeption ;ein Termin beim Arzt. Treffen im Cafe		
Module:8		**2 hours**
Guest Lectures/Native Speakers / Feinheiten der deutschen Sprache, Basisinformation über die deutschsprachigen Länder		

	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	**Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme : 2012**
Reference Books	
1	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, 2013
2	Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
3	Deutsche SprachlehrefürAUsländer, Heinz Griesbach, Dora Schulz, 2011
4	ThemenAktuell 1, HartmurtAufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010
	www.goethe.de wirtschaftsdeutsch.de hueber.de klett-sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	41	Date	17.06.2016

Course code	Course title	L	T	P	J	C
STS 4001	Essentials of Business Etiquette and problem solving	3	0	0	0	1
Pre-requisite	None	Syllabus version				

Course Objectives:

1.To develop the students' logical thinking skills
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To enhance critical thinking and innovative skills

Expected Course Outcome:

1. Enabling students to use relevant aptitude and appropriate language to express themselves
2.To communicate the message to the target audience clearly
3. The students will be able to be proficient in solving quantitative aptitude and verbal ability questions of various examinations effortlessly

Module:1	Business Etiquette: Social and Cultural Etiquette and Writing Company Blogs and Internal Communications and Planning and Writing press release and meeting notes	9 hours

Value, Manners, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information, Analysis, Determining, selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body – Make it relevant to your audience,

Module:2	Study skills – Time management skills	3 hours

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, working under pressure and adhering to deadlines

Module:3	Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions	7 hours

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	**Quantitative Ability -L1 – Number properties and Averages and Progressions and Percentages and Ratios**	**11 hours**
Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions		
Module:5	**Reasoning Ability-L1 – Analytical Reasoning**	**8 hours**
Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzle test, Selection Decision table		
Module:6	**Verbal Ability-L1 – Vocabulary Building**	**7 hours**
Synonyms & Antonyms, One-word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler (2001) Crucial Conversations: Tools for Talking When Stakes are High. Bangalore. McGraw-Hill Contemporary
2.	Dale Carnegie, (1936) How to Win Friends and Influence People. New York. Gallery Books
3.	Scott Peck. M (1978) Road Less Travelled. New York City. M. Scott Peck.
4.	FACE (2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications
5.	ETHNUS (2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites:

1.	**www.chalkstreet.com**
2.	**www.skillsyouneed.com**
3.	**www.mindtools.com**
4.	**www.thebalance.com**
5.	**www.eguru.ooo**

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Course code	Course title	L	T	P	J	C
STS 4002	Preparing for Industry	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				
Course Objectives:	• To challenge students to explore their problem-solving skills • To develop essential skills to tackle advance quantitative and verbal ability questions • To have working knowledge of communicating in English					
Expected Course Outcome:	• Enabling students to simplify, evaluate, analyze and use functions and expressions to simulate real situations to be industry ready. • The students will be able to interact confidently and use decision making models effectively • The students will be able to be proficient in solving quantitative aptitude and verbal ability questions of various examinations effortlessly					
Module:1	**Interview skills – Types of interview and Techniques to face remote interviews and Mock Interview**	**3 hours**				
Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview¸ Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds						
Module:2	**Resume skills – Resume Template and Use of power verbs and Types of resume and Customizing resume**	**2 hours**				
Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio						
Module:3	**Emotional Intelligence - L1 – Transactional Analysis and Brain storming and Psychometric Analysis and Rebus Puzzles/Problem Solving**	**12 hours**				
Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways						
Module:4	**Quantitative Ability-L3 –**	**14 hours**				

	Permutation-Combinations and Probability and Geometry and mensuration and Trigonometry and Logarithms and Functions and Quadratic Equations and Set Theory	
Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram		
Module:5	**Reasoning ability-L3 – Logical reasoning and Data Analysis and Interpretation**	**7 hours**
Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats		
Module:6	**Verbal Ability-L3 – Comprehension and Logic**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument		
	Total Lecture hours:	**45 hours**
References	• Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota. Jist Works • Daniel Flage Ph.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson • FACE(2016) Aptipedia Aptitude Encyclopedia.Delhi. Wiley publications	
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)		