Annexure – I

CENTRAL UNIVERSITY OF SOUTH BIHAR

Master of Science in Biotechnology (M.Sc Biotechnology) Programme Syllabus

(Effective from Academic Session 2019-2020)

Department of Biotechnology
SCHOOL OF EARTH, BIOLOGICAL AND ENVIRONMENTAL SCIENCES

Central University of South Bihar
Department of Biotechnology
Proposed Course Structure for M. Sc. Biotechnology
Course Duration: 2 years [4 Semesters] (100 Credits)

The Department of Biotechnology is currently offering M. Sc. Biotechnology. The Programme includes well-designed theory and practical courses. Innovation-based training is the key to train students with a special emphasis on understanding the basic as well as modern concepts in biological processes for pursuing research in frontier areas of Biological Sciences. The Programme equip students with deep theoretical as well as practical understanding of different aspects of Biological processes and promote them to take on an integrative approach for their studies and research.

Biotechnology has emerged as a major thrust in the field of science and technology having potential to boost the economy of several countries including India. The voice of global Biotechnology in 21st century is to transfer the bio-based technology from “Lab to Land and from Bench to Business” to bring the cost of bio-based commodities within the reach of common man. The courses in Biotechnology Programme are mainly related to recent and emerging trends in Biology but the students are also taught Biostatistics which enables them to analyse their data, draw meaningful conclusions and publish in reputed journals. The Programme equally gives emphasis on integrated approaches in human health, recombinant DNA technology, transgenic development, bioremediation and informatics. Students work directly with faculty on real-world projects, gaining hands-on skills necessary to solve emerging problems.

Department of Biotechnology is equipped with state-of-the-art technology and equipment that provide a stimulating environment for teaching and research.

Biotechnology Programme

M. Sc. Biotechnology Programme

The two year (four semesters) Post-Graduate Programme has interdisciplinary approach with participation of faculty/researchers across the University based on CBCS pattern. Hands-on training with professional and management skills are keys to our teaching pedagogy. This Programme focuses on responsibility building and ethics in research and policy. We are equally giving emphasis on integrated approaches in human health, transgenic crop development, environmental sciences and informatics. The course also comprises of project dissertation, presentation and comprehensive viva-voce as part of evaluation system. Students also visit major research institutes in the form of educational/excursion tour and Biotechnology industries to learn various aspects of product developments. One of the major goals of the Biotechnology Programme is to engage students by actively involving them in cutting-edge research.

Currently, departmental research is mainly focussed in the areas of Cancer Biology, Autoimmune Diseases, Fungal Diseases, Lung Physiology, Neuroethology, Immunology, Genetic Engineering, Stem Cell Therapy, Proteomics, Molecular Biology, Signal Transduction, Interferon (IFNs) Transcription Factors, Neuroimaging, Electrophysiology, Biochemistry of Fungal Pathogens and Genesis of Secondary Metabolites as well as

Genetic manipulations of Plants which include Plant Tissue Culture and Molecular Marker Developments. Apart from above advantages, M.Sc. Biotechnology Programme prepares the students to be the leaders in research, policy and business.

microbioBiotechnology Laboratory

Biotechnology Laboratory is equipped with state of the art technology and equipment that provide a stimulating environment for teaching and research. The list includes Biosafety Cabinets, Laminar Air Flow, Autoclave, Water bath with wide temperature ranges, Dry Block Heater (Heating Block), Rotatory Shaker, Stackable Incubator Shaker, Cell Sonicator, Many types of Microscopes (Fluorescence, Inverted, Compound), various types of refrigerated Centrifuges, Nano Drop UV/VIS Spectrophotometer, ELISA Plate Reader, Spectrophotometer, Gradient Thermal Cycler, Real-Time PCR, UV/VIS Transilluminator, Gel Documentation Systems, Electrophoresis units (Horizontal and Vertical), Blot Transfer System, Deep Freezers (-20^0 C and -86^0 C), Ice-Flakes Machine, Cryo-Can, Lyophilizer, Complete Milli-Q Water System etc. Facilities for animal, plant and microbial culture work are also available.

Core Courses

Course Code	Courses	Credits		
		L	T	P
Core	**Semester I**			
MSBTN1001C04	Cell Biology & Genetics	**3**	**1**	**0**
MSBTN1002C04	Biomolecules & Biochemistry	**3**	**1**	**0**
MSBTN1003C04	Instrumentation: Tools & Techniques in Biotechnology	**3**	**1**	**0**
MSBTN1004C04	Bioinformatics and Biostatistics	**3**	**1**	**0**
MSBTN1005C04	Lab 1 related to MSBTN1001C04 + MSBTN1002C04+ MSBTN1003C04	**0**	**1**	**3**
	Semester II			
MSBTN2001C04	Molecular Biology and Genomics	**3**	**1**	**0**
MSBTN2002C04	Microbiology	**3**	**1**	**0**
MSBTN2003C04	Enzymology	**3**	**1**	**0**
MSBTN2004C04	Biology of Immune System	**3**	**1**	**0**
MSBTN2005C04	Lab 2 related to MSBTN2001C04+ MSBTN2002C04	**0**	**1**	**3**
MSBTN2006C04	Lab 3 related to MSBTN2003C04+ MSBTN2004C04	**0**	**1**	**3**
	Semester III			
MSBTN3001C04	Recombinant DNA Technology	**3**	**1**	**0**
MSBTN3002C04	Bioprocess Engineering	**3**	**1**	**0**
MSBTN3003C04	Animal Biotechnology	**3**	**1**	**0**
MSBTN3004C04	Plant Biotechnology	**3**	**1**	**0**
MSBTN3005C04	Lab 4 related to MSBTN3001C04+ MSBTN3002C04	**0**	**1**	**3**
MSBTN3006C04	Lab 5 related to MSBTN3003C04+ MSBTN3004C04	**0**	**1**	**3**
	Semester IV			

MSBTN4001C16	Project Dissertation, Presentation and Comprehensive *Viva-voce#*	**0**	**2**	**14**
Total Credit for Core Course		**84**		

 # The student shall carry out the dissertation work outside CUSB or as recommended by DC. Department will provide the recommendation letters for the same. However, they have to follow the academic calendar of the CUSB.

Elective Courses

Course Code	**Courses**	**Credits**		
		L	**T**	**P**
Elective	**Any Four to be chosen (Two from parent Department and Two from Other Department)**			
MSBTN1001E04	Biodiversity and Ecobiotechnology**	**3**	**1**	**0**
MSBTN1002E04	Metabolism and Metabolic Engineering	**3**	**1**	**0**
MSBTN2001E04	Cancer Biology *	**3**	**1**	**0**
MSBTN2002E04	IPR, Bioethics and Biosafety **	**3**	**1**	**0**
MSBTN2003E04	Neuroscience *	**3**	**1**	**0**
MSBTN3001E04	Neurological Diseases and Techniques*	**3**	**1**	**0**
MSBTN3002E04	Techniques in Molecular Diagnostics and stem Cell Technology	**3**	**1**	**0**
Total Credit for Elective Course		**16**		

* Can be offered to other Dept. within school
** Can be offered to other School

Skill Courses (Non-Credits)

Skill Based Electives		**L**	**T**	**P**
MSBTN3001S00	*Drosophila* Techniques	**0**	**0**	**0**
MSBTN3002S00	Village Based Skills	**0**	**0**	**0**
MSBTN3003S00	Field and Excursion Tour	**0**	**0**	**0**

Swayam/Self Study Based Courses (Non – Credits) Course Code	**Courses**			
		L	**T**	**P**
MSBTN1001S02	Introductory Mathematical Methods for Biologists			
MSBTN2001S02	Bio-energetics of Life Processes			
MSBTN3001S02	Principles of Downstream Techniques in Bioprocess			
MSBTN4004S02	Human Molecular Genetics			

Note - Swayam based courses are updated regularly and students can opt any other updated courses even if it is not mentioned in the list given above.

ASSESSMENT AND EVALUATION IN BIOTECHNOLOGY FOR CORE COURSES (Date 10/5/2019)

FIRST SEMESTER

Course Details			
Course Title: Cell Biology and Genetics			
Course Code	MSBTN1001C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The main aims of this course is to teach students basic concepts in cell biology and genetics, and an introductory level understanding of the methodologies associated with these disciplines. The students will be able to develop an understanding that science is a continual process of investigation and interpretation, and that scientific knowledge progresses via the support and rejection of competing hypotheses, collective decisions that are based on empirical evidence and logical interpretation using inductive and deductive reasoning.

Learning Outcomes

Discoveries in genetics and cell biology are opening up a new era of understanding, both of ourselves and of the world around us. Genetics give us insight into what contributes to our development and individuality, and when this knowledge is combined with cell biology, you can explore exciting scientific applications benefiting all of society.

Course Contents

UNIT I: Diversity of Cells: (30% Weightage)

Structure and functions, Prokaryotic, Eukaryotic cells. The structural and functional organizations of cell membrane, ionic transport (Passive and active transport), the extra-cellular matrix of eukaryotes, cell wall. Structure and functions of endoplasmic reticulum, golgi complex, ribosome lysosomes, peroxisomes (glyoxysomes), plastids and mitochondria. Nucleus and Nuclear ingredients, Proteins associated with nuclei. Packaging of genetic material: nucleosome model, Organization of chromatin: chromosome structure.

UNIT II: (25 % Weightage)

Cell-cycle and Regulation: Steps in cell cycle, yeast as a model system, cell division control and regulation: yeast *cdc* gene, role of cyclins and cdk. Cell signaling: Exocrine, Endocrine, Paracrine and Synaptic strategies of Chemical signaling, surface receptor mediated transduction (DAG, Ca^{+2}, c-AMP, G-Proteins).

UNIT III: Concept of cell signaling Pathways: (20 % Weightage)
MAPK, Ras, ATM, ATR, Oncogenesis. Cytoskeleton and cell motility: Microtubules, microfilaments and intermediate elements.

UNIT IV: Cytogenetics: (15 % Weightage)
Linkage and Crossing over. Linkage mapping. Sex determination and sex linked inheritance, Sex determination in plant and animal, Population and evolutionary genetics.

UNIT V: Gene mutation: (10% Weightage)
Types of mutations, Site directed mutagenesis, DNA damage & repair, Ageing.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	***Diversity of Cells***
1-2	Structure and functions, Prokaryotic, Eukaryotic cells
3-6	The structural and functional organizations of cell membrane, ionic transport (Passive and active transport), the extra-cellular matrix of eukaryotes, cell wall
7-10	Structure and functions of endoplasmic reticulum, golgi complex, ribosome lysosomes, peroxisomes (glyoxysomes), plastids and mitochondria
11--13	Nucleus and Nuclear ingredients, Proteins associated with nuclei.
14-16	Packaging of genetic material: nucleosome model, Organization of chromatin: chromosome structure
Unit II	***Cell-cycle and Regulation***
17-20	Steps in cell cycle, yeast as a model system, cell division control and regulation: yeast *cdc* gene, role of cyclins and cdk
21-23	Cell signaling: Exocrine, Endocrine, Paracrine and Synaptic strategies of Chemical signaling
24-27	surface receptor mediated transduction (DAG, Ca+2, c-AMP, G-Proteins).
Unit 3	***Concept of cell signaling Pathways***
28-31	MAPK, Ras, ATM, ATR
31-33	Oncogenesis
34-36	Cytoskeleton and cell motility: Microtubules, microfilaments and intermediate elements
Unit 4	***Cytogenetics***
37-39	Linkage and Crossing over. Linkage mapping
40-41	Sex determination and sex linked inheritance
42-43	Sex determination in plant and animal
44-45	Population and evolutionary genetics
Unit 5	***Gene mutation***
35	Types of mutations
38-39	Site directed mutagenesis
40-43	DNA damage & repair
44-45	Ageing
15 Hours	*Tutorials*

- Suggested References:

1. Cell (A Molecular approach): Cooper, G. M.(2009)
2. Cell and Molecular Biology (2017) Karp, G.
3. Cell Biology (2009) Sadava D. E.
4. Cell and Molecular Biology (2011) Kish V. M. and Kleinsmith L. J.
5. Cell and Molecular Biology : deRobertis and deRobertis (2011)

Course Details			
Course Title: Biomolecules & Biochemistry			
Course Code	MSBTN1002C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To train students to understand about different biomolecules, their structure and function.
- To acquaint the students with the chemistry of biological systems and to unravel the chemistry of the living state.
- To help the students unravel the importance of biomolecules in medical and clinical problems.
- To develop the ability to understand and do research on different biochemical problems up to molecular level.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand about different biomolecules of life.
- Analyze different biochemical processes and their significance.
- Plan different biochemical tests in order to know about diseases.

Course Contents

Unit I: Proteins (25% Weightage)

Structure, properties, classification and functions, naturally occurring modifications of amino acids in proteins, non-protein amino acids. Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Ramachandran plots.

Unit II: Carbohydrates (20% Weightage)

Classification, types, Optical isomerism, Mutarotation, Basic structure and functions of monosaccharides, oligosaccharides, polysaccharides, Proteoglycans, Glycoproteins.

Unit III: Lipids **(25% Weightage)**

Classification, structure, properties and function of Fatty acids, Phospholipids, Glycolipids, Sphingolipids, Cerebrosides, Steroids, Prostaglandins.

Unit IV: Metabolic pathways **(15% Weightage)**

Glycolysis, Krebs cycle, Oxidative phosphorylation, Biosynthesis of purines and pyrimidines, *de Novo* and salvage pathway.

Unit V: Bonds and Interactions in Biochemistry **(15% Weightage)**

Details of various bonds and forces in biomolecules, pH, pK, buffers, acid base theories, ionization of weak acids and bases, Henderson Hasselbalch equation, Titration curves and buffering action. Laws of thermodynamics, Gibb's free energy, Donan's membrane equilibrium.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
	Unit I: Proteins
1-8	Structure, properties, classification and functions
9	Naturally occurring modifications of amino acids in proteins
10	Non-protein amino acids
11	Ramachandran plots
	Unit II: Carbohydrates
12-15	Classification, types
16-17	Optical isomerism, Mutarotation
18	Basic structure and functions of monosaccharides, oligosaccharides, polysaccharides
19	Proteoglycans, Glycoproteins
20	Peptidoglycans and bacterial cell walls
	Unit III: Lipids
21-24	Classification, structure, properties and function of Fatty acids
25	Phospholipids
26-27	Glycolipids, Sphingolipids
28	Cerebrosides
29-31	Steroids, Prostaglandins
	Unit IV: Metabolic pathways
32-34	Glycolysis, Krebs cycle
35-36	Oxidative phosphorylation
37	Biosynthesis of purines and pyrimidines, *de Novo* and salvage pathway
	Unit V: Bonds and Interactions in Biochemistry
38	Details of various bonds and forces in biomolecules
39-40	pH, pK, buffers
41	Acid base theories, ionization of weak acids and bases
42-43	Henderson Hasselbalch equation, Titration curves and buffering action
44	Laws of thermodynamics
45	Gibb's free energy, Donan's membrane equilibrium

15 Hours	Tutorials

Suggested References:

1) Ferrier D. R. (2013) Biochemistry (Lippincott's Illustrated Reviews Series), 6th Edition
2) Garrett R. H. and Grisham C. M. (2012) Biochemistry, 5th Edition.
3) Lehninger A, Nelson D. L. and Cox M. M. (2008) Principles of Biochemistry, 5th Edition.
4) Berg J. M., Tymoczko J. L. and Stryer L (2010) Biochemistry, 7th Edition.
5) Voet D. and Voet J. G. (2010) Biochemistry, 4th Edition.

Course Details			
Course Title: Instrumentation: Tools & Techniques in Biotechnology			
Course Code	MSBTN1003C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T)
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, individual field based assignments followed by Classroom presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To aware students with the basic concept, principle and application of various instruments commonly used to conduct experiments in biotechnology.
- To orient the students with tools and techniques of used in Biotechnology for performing results and analysis of data obtained.
- To make the students understand how various requirements of education are measured, evaluated, interpreted and their result recorded to help learners.
- To develop skills and competencies in constructing and standardizing a test.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand basic principle of different Instruments used in Biotechnology.
- Differentiate among measurement, assessment and evaluation.

Course Contents

UNIT I: Microscopic and Centrifugation Techniques (23 % Weightage)

Microscopic and Centrifugation Techniques: Principles and applications: simple, compound, phase-contrast and fluorescence microscopes. Electron microscopy: SEM and TEM; confocal.

Principles and different types of Centrifugation; Differential and density gradient centrifugation of biomolecules and their applications.

UNIT II: Spectrophotometric Techniques (23 % Weightage)

Spectrophotometric Techniques: Electromagnetic spectrum, Beer Lambert's Law, UV/VIS, Fluorescent spectroscopy, Spectrophotometry, Infrared

spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy, Circular Dichroism. Flow Cytometry, ELISA

UNIT III: Chromatographic techniques: (18 % Weightage)

Types of chromatography, paper, thin layer, gas, Gel permeation, ion-exchange, HPLC, and affinity chromatography; Applications of Chromatographic techniques in Biology

UNIT IV: Electrophoretic Techniques (24% Weightage)

Agarose, Polyacrylamide gel (native and SDS), Immunoelectrophoresis, Isoelectric focusing and 2-Dimension gel electrophoresis

UNIT V: Radiotechniques (13% Weightage)

Radioactivity and its decay, Geiger-Müller counter**,** Scintillation counter, Autoradiography Safety measures in handling radioisotopes. RIA, non-radiolabelling.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I: Microscopic and Centrifugation Techniques	
1-2	Principles and applications: simple, compound Microscope
3	Phase-contrast Microscope
4	Fluorescence microscopes.
5	Electron microscopy: SEM and TEM
6	Confocal microscope
7-8	Principles and different types of Centrifugation
9-10	Differential and density gradient centrifugation of biomolecules and their applications
Unit II: Spectrophotometric Techniques	
11	Electromagnetic spectrum, Spectrophotometry, Beer Lambert's Law
12	UV/VIS
13	Fluorescent spectroscopy
14	Infrared spectroscopy
15	Atomic absorption spectroscopy
16	NMR spectroscopy
17	ESR and Mass spectroscopy
18	Circular Dichroism
19	Flow Cytometry
20	ELISA
UNIT III: Chromatographic techniques:	
21	Types of chromatography,

22-23	Paper, thin layer chromatography, Gas chromatography,
24-26	Gel permeation, ion-exchange, affinity chromatography
27-28	HPLC, Applications of Chromatographic techniques in Biology
UNIT IV: Electrophoretic Techniques	
29-30	Agarose Gel electrophoresis
31-33	Polyacrylamide gel (native and SDS),
34-35	Immunoelectrophoresis
36-39	Isoelectric focusing and 2-Dimension gel electrophoresis
UNIT V: Radiotechniques	
40-41	Radioactivity and its decay,
42	Geiger-Müller counter
43	Scintillation counter,
44	Autoradiography, Safety measures in handling radioisotopes
45	RIA, non-radiolabelling
15 Hours	*Tutorials*

Suggested References:

- White R (1990) Biochemical Techniques theory and practice. Waveland Press.
- Christion G. D. (2003) Analytical Chemistry (6th edition), Wiley.
- Wilson K. and Walker J. (2010) Principles & Techniques of Biochemistry & Molecular Biology (7th edition).Cambridge University Press, UK
- Plummer D. T. (2007) An Introduction to Practical Biochemistry (3rd edition).Tata McGraw-Hill Education.
- Skoog D. A., F, Holler J., Crouch S.R.(2007) Principles of Instrumental analysis (6th edition), Cengage Learning, USA.

Course Details			
Course Title: Bioinformatics and Biostatistics			
Course Code	MSBTN1004C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T)
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, individual field based assignments followed by Classroom presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This course is an introduction to bioinformatics and a practical guide to the analysis of genes and proteins. It covers computational tools and databases widely used in bioinformatics.
- This course is designed to provide a broad overview of biostatistics methods as well as applications commonly used in bioscience research. Topics covered include measurement and categorizing variables, use and misuse of descriptive statistics, testing hypotheses, and applying commonly used statistical tests.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will learn about biological databases, computational tools to analyse biological data, microarray analysis, proteomics and role of Bioinformatics in drug discovery.
- Students will learn how to choose and apply statistical tools to data sources, when and how statistical tools can be used to analyze data, and how to interpret others' quantitative studies.

Course Contents

UNIT I: Introduction to Bioinformatics (25 % Weightage)

Biological Databases - uses –Sequence databases-Nucleic acid (NCBI, EMBL, DDBJ), Proteins-(SWISSPROT), Structural databases- PDB, Specialised databases – KEGG, OMIM, PubMed. Global and Local alignment, Pairwise and multiple sequence alignment, Database Similarity Searches: BLAST.

UNIT II: Data analysis (25 % Weightage)

Microarray data analysis methods, tools and resources, SAGE (Serial analysis of gene expression). Proteomic data analysis –Analyzing data from 2D-PAGE gels, Bioinformatics in pharmaceutical industry: Drug discovery and pharmacogenomics.

UNIT III: Introduction and descriptive data analysis (25% Weightage)

Introduction to biostatistics, concept of variables in biological systems. Data representation and summary measures for central tendency, dispersion, skewness and kurtosis of a frequency distribution. Classical, frequency and axiomatic approach of calculating probability, conditional probability and Bayes theorem. probability distribution: bionomial and normal distribution.

UNIT IV: Inferential statistics (25% Weightage)

Concepts of population and sample. Making inference about population from sample, framing hypothesis and possible errors. Testing hypothesis about mean: one sample and two sample cases. ANOVA and regression analysis.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I: Introduction to Bioinformatics	
1-10	
UNIT II: Data analysis	
11-25	
UNIT III: Introduction and descriptive data analysis	
26-36	
UNIT IV: Inferential statistics	
37-45	
15 Hours	*Tutorial*
1-3	**Experiment 1**: Retrieval of nucleotide/protein sequences from biological/forensic databases.
4-6	**Experiment 2:** Visualization of protein structure using a file from

	Protein Data Bank.
7-9	**Experiment 3:** Sequence alignment using online BLAST family of programs.
10-12	**Experiment 4:** Multiple sequence alignment.
13-15	**Experiment 5:** Dot plot analysis and Primer designing.

Suggested References:

1. Bioinformatics: Sequence and Genome Analysis, Second Edition by David Mount (2004)
2. Introduction to Bioinformatics, 3rd Edition by Arthur Lesk (2008)
3. Introduction to Bioinformatics by Teresa Attwood and David Parry-Smith (2001)
4. Introduction to Bioinformatics: A Theoretical and Practical Approach, 1st Edition by Stephen A. Krawetz and David D. Womble (2003)
5. Introduction to Bioinformatics and Microarray Technology by Abhilash M (Author) (2010)
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition by Andreas D. Baxevanis (Editor), B. F. Francis Ouellette (Editor) (2004)
7. Guide to Analysis of DNA Microarray Data, 2nd Edition by Steen Knudsen (2004)
8. Microarray Analysis, 1st Edition by Mark Schena (2002)
9. Microarray Data Analysis and Visualization by Arun Jagota (Author) (2001)
10. Daniel W W (2009) Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley
11. Das N G (2008) Statistical methods. Mcgraw Hill Education.
12. Das K K (2010) An introduction to probability theory. Asian Books Pvt Ltd
13. George A (2012) Mathematical methods for physicists. Orlando Academic Press.
14. Nabendu P, Sahadeb S (2005) Statistics: Concepts and Applications. PHI Learning Pvt. Ltd.
15. Rosner B (2010) Fundamentals of Biostatistics. Cengage Learning, Inc.
16. Stephenson G, Radmore PM (1990) Advanced Mathematical Methods for Engineering and Science Students. Cambridge University Press.

Course Details			
Course Title: Lab 1 related to MSBTN1001C04 + MSBTN1002C04+ MSBTN1003C04			
Course Code	MSBTN1005C04	**Credits**	4
L + T + P	0 + 1 + 3	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	15 (T) + 90 (P) Hours
Methods of Content Interaction	Tutorials, Hands-on; self-study, seminar, presentations by students, individual and group performance of experiment.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- By the end of this module students should be able to describe the principles of experimental design and the stages of development of a practical protocol in cell biology and genetics.

- The course is designed to give training covering both classical and applied aspects of biochemistry beginning from basic techniques like qualitative and quantitative analysis of various biomolecules and bio-analytical techniques.
- This practical course has been designed not only to enable the students to appreciate scientific basis of various life processes and applying the knowledge to real life situations by introducing research methodologies but also to train them for self-employment. The practical training will develop their reasoning ability to critically evaluate the results obtained from different experiments and projects.

Learning Outcomes

After completion of the course the learners will be able to:

- After doing this practical course, the students will be able to learn the concepts and principles of various experiments related to Cell Biology, Genetics and Biochemistry commonly conducted in Biotechnology.
- The major outcome of the course is to demonstrate the laboratory experiments with training in the use of analytical instrumentation with methods of data analysis and interpretation.
- Student will get the idea about the experiments related to enzyme.

Course Contents

UNIT I: MSBTN1001C04: Cell Biology & Genetics (24% Weightage)

Experiment 1: Blood grouping
Experiment 2: Mitosis in onion root tips
Experiment 3: Study of osmosis
Experiment 4: Isolation of chloroplast
Experiment 5: Subcellular fractionation by differential centrifugation
Experiment 6: Analysis on subcellular fractionations on gel

UNIT II: MSBTN1002C04: Biomolecules and Biochemistry (36 % Weightage)

Experiment 1: Qualitative analysis of lipids by Acrolein test.
Experiment 2: Qualitative analysis of cholesterol by Salkowski test.
Experiment 3: Qualitative analysis of amino acids by Ninhydrin test.
Experiment 4: Qualitative analysis of proteins by Biuret test.
Experiment 5: Qualitative analysis of carbohydrates by Molisch's test.
Experiment 6: Qualitative analysis of reducing and non-reducing carbohydrates by Fehling's test and Bradford's test.
Experiment 7: Preparation of standard curve for quantitative estimation of proteins using BSA by Lowry's method.
Experiment 8: Methylene Blue Reductase Test.
Experiment 9: Tests for food adulterations.

UNIT III: MSBTN1003C04: Instrumentation: Tools & Techniques in Biotechnology (40 % Weightage)

Experiment 1: To locate a protein expression in the cell using fluorescence microscopy.
Experiment 2: To calculate cell numbers of the given microbial cell using the spectrophotometer.
Experiment 3: Quantitative estimation of purified DNA by UV spectrophotometer.
Experiment 4: To determine the Molar Extinction Coefficient (ε) of the given sample
Experiment 5: Determine of substrate concentration of the given unknown solution by Lambert's Beer's Law.

Experiment 6: To analyse molecular weight of the given DNA sample using Gel documentation unit.
Experiment 7: To perform SDS-PAGE for separation of proteins in a given sample/western blot.
Experiment 8: To perform size exclusion/Ion exchange/RP chromatography for protein purification.
Experiment 9: To analyse the FT-IR peaks obtained from biopolymers such as soy protein isolate, polylactic acid and polyfurfuryl alcohol.
Experiment 10: To analyse the NMR peaks of different amino acids.

Content Interaction Plan:

Practical cum Discussion (Each session of 3 Hour)	**Unit/Topic/Sub-Topic**
Unit I	**Cell Biology & Genetics**
1-3	Experiment 1
4-6	Experiment 2
7-9	Experiment 3
10-15	Experiment 4
16-18	Experiment 5
19-21	Experiment 6
Unit II	**Biomolecules and Biochemistry**
1-3	Experiment 1: Qualitative analysis of lipids by Acrolein test.
4-6	Experiment 2: Qualitative analysis of cholesterol by Salkowski test.
7-9	Experiment 3: Qualitative analysis of amino acids by Ninhydrin test.
10-12	Experiment 4: Qualitative analysis of proteins by Biuret test..
13-15	Experiment 5: Qualitative analysis of carbohydrates by Molisch's test.
16-18	Experiment 6: Qualitative analysis of reducing and non-reducing carbohydrates by Fehling's test and Bradford's test.
19-24	Experiment 7: Preparation of standard curve for quantitative estimation of proteins using BSA by Lowry's method.
25-27	Experiment 8: Methylene Blue Reductase Test.
28-33	Experiment 9: Tests for food adulterations.
Unit III	**Instrumentation: Tools & Techniques in Biotechnology (36 % Weightage)**
1-3	Experiment 1
4-6	Experiment 2
7-9	Experiment 3
10-12	Experiment 4
13-15	Experiment 5
16-18	Experiment 6
19-21	Experiment 7
22-27	Experiment 8
28-30	Experiment 9
31-36	Experiment 10

15 Hours	Tutorials

- Suggested References:

1. An introduction to practical Biochemistry by David T. Plummer, Tata McGrawHill Publishing Company Limited, New Delhi
2. Introductory Practical Biochemistry (2nd Edition) by S. K. Sawhney (Editor), Randhir Singh (Editor), Alpha Science International, Ltd.
3. Practical Biotechnology: Methods and protocols by S Janarthana and S Vincent, University press 2017
4. Experimental Biotechnology by Sunita Dutta and Abhijit Dutta and AK Choudhary, New India Publisher 2011

SECOND SEMESTER

Course Details			
Course Title: Molecular Biology and Genomics			
Course Code	MSBTN2001C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The objective of this course is to teach students about basic concepts in Molecular Biology and Genomics, and an introductory level understanding of the methodologies associated with this discipline. The course will enable students to learn improved research skills and the ability to critically assess the content value of different types of information.

Learning Outcomes

- The molecular Biology and Genomics course provide you with the theoretical and practical resources for a career in the health care industry. You will enhance your biology expertise and learn the laboratory skills that are the foundation for major, modern scientific breakthroughs that affect society.

Course Contents

UNIT I: Nucleic acids (20% Weightage)

Structure, properties and functions of DNA and RNA, Secondary and tertiary level organization, Various DNA forms, Super coiling, Melting of DNA, Thermal Denaturation and Renaturation kinetics, Co_t Curve, DNA Replication.

UNIT II: Prokaryotic and eukaryotic gene expression (20 % Weightage)

Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes *Vs* Eukaryotes, Spliceosome. Transcriptomics.

UNIT III: Translation (20 % Weightage)

Translation: Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation. Post-translational modifications and intracellular proteins transport.

UNIT IV: Gene regulation (20% Weightage)

Control of gene expression in prokaryotes and eukaryotes, operon model: ***lac*** and ***trp*** operon, Autogenous regulation: Induction and Repression, Feedback inhibition, Lytic cascades and lysogenic repression.

UNIT V: Genome Analysis (20% Weightage)

Whole Genome analysis, DNA microarray. Gene mapping and applications- Transcriptome and Proteome- General Account. Protein microarrays. Advantages and disadvantages of DNA and protein microarrays.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	***Nucleic acid***
1-3	Structure, properties and functions of DNA and RNA, Secondary and tertiary level organization
4-5	Various DNA forms, Super coiling, Melting of DNA
6-7	Thermal Denaturation and Renaturation kinetics, Co_t Curve
8-9	DNA Replication mechanism of E. coli and Yeast
Unit II	***Prokaryotic and eukaryotic gene expression***
10-12	Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase
12	Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences
13	Initiation and termination of transcription factor
14-15	RNA processing in Prokaryotes *Vs* Eukaryotes
16-17	Spliceosome
18	Transcriptomics
Unit 3	***Translation Mechanism***
19-20	Prokaryotic and Eukaryotic translation, the translation machinery
21	Mechanisms of initiation, elongation and termination
21-22	Regulation of translation. Post-translational modifications and intracellular proteins transport
23-24	Post-translational modifications
25-26	Intracellular proteins transport
Unit 4	***Gene regulation***
27-28	Control of gene expression in prokaryotes and eukaryotes, operon model: ***lac*** and ***trp*** operon
29-31	Autogenous regulation: Induction and Repression, Feedback inhibition, Lytic cascades and lysogenic repression
Unit 5	***Genomics***
32-34	Whole Genome analysis, DNA microarray
35-37	Gene mapping and applications
38-40	Transcriptome and Proteome
41-43	General Account. Protein microarrays
44-45	Advantages and disadvantages of DNA and protein microarrays
15 Hours	*Tutorials*

- Suggested References:

1. Molecular Biology of the Gene (2009) Watson J. D., Hopking N., Robast J. and Steiz, J.6th edition
2. Lewin's Genes XI.
3. The Biochemistry of the nucleic acid (2008) Adams et al 11th edition

4. Molecular Biology: David Fridflelder (2008)
5. Molecular cell Biology (2008) Lodish, H., Baltimore, D., Berk, A, Zipursky SL, Paul M and Darnell J.6th edition
6. Cell and Molecular Biology (2010) Gerald Karp. 6th edition

Course Details			
Course Title: Microbiology			
Course Code	MSBTN2002C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- A general course emphasizing history, distribution, morphology, taxonomy and physiology of microorganisms.
- Skills in aseptic procedures, isolation, identification and studying microbial growth control methods.
- This course also includes areas covering virology, epidemiology and DNA technology.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will learn the importance of microorganism in real world.
- Students will have the concept of different types of organism.
- They will know the techniques involved to get the identification and isolation of microbes.
- Student will get the idea about host pathogen interaction.

Course Contents

UNIT I: Introduction to Microbiology (20% Weightage)

History and Scope of Microbiology, Major characteristics used in microbial taxonomy (numerical and molecular), Culture media and their types. Pure Culture Techniques- Serial dilution methods - spread plate – pour plate – streak plate technique. Molecular methods of microbial identification, and characterization from environment.

UNIT II: Structure of Microbes (20 % Weightage)

Ultrastructure of Bacteria, Archaebacteria, Cyanobacteria, Virus (Plant and Animal virus), and Fungi

UNIT III: Microbial Growth (20 % Weightage)

Microbial Growth: Nutritional requirements of micro-organisms, mode of nutrition, phototrophy, mixotrophy, saprophytic, symbiotic and parasitic organisms, microbial

growth and population kinetics, methodology for measuring growth and growth regulation. Physical and chemical control of microbes.

UNIT IV: Genetic Recombination in microbes (15% Weightage)
Transformation, transduction (generalized & specialized), conjugation.

UNIT V: Host-pathogen Interactions (25% Weightage)
Basic concepts, action of pathogens, human pathogenic viruses and bacteria, Bacterial agents of disease. Life cycle of some important pathogens like- Malaria, hepatitis, Tuberculosis, Kala-Azar and AIDS.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	***Introduction to Microbiology***
1	Major characteristics used in microbial taxonomy
2-3	Numerical and molecular
4-5	Culture media and their types.
6	Pure Culture Techniques-Serial dilution methods
7-8	spread plate – pour plate – streak plate technique
9	Molecular methods of microbial identification, and characterization from environment.
Unit II	***Structure of Microbes***
10	Ultrastructure of Bacteria
11-12	Archaebacteria
13	Cyanobacteria
14-15	Virus
16	Plant and Animal virus
17-18	Fungi
Unit 3	***Microbial Growth***
19	Nutritional requirements of micro-organisms,
20	Mode of nutrition,
21-22	Phototrophy, mixotrophy, saprophytic, symbiotic and parasitic organisms
23-24	Microbial growth and population kinetics
25	Methodology for measuring growth and growth regulation
26	Physical control of microbes
27	Chemical control of microbes
Unit 4	***Genetic Recombination in microbes***
28	Conjugation
29-30	Transformation
31	transduction,
32-33	Generalized transduction
34-36	Specialized transduction.
Unit 5	***Host-pathogen Interactions***
37	Basic concepts
38-39	Action of pathogens

40	Human pathogenic viruses and bacteria
41	Bacterial agents of disease
42	Life cycle of some important pathogens like- Malaria
43	Life cycle of some important pathogens like- hepatitis
44	Life cycle of some important pathogens like- Tuberculosis
45	Life cycle of some important pathogens like- Kala-Azar and AIDS
15 Hours	*Tutorials*

Suggested References:

1. Alcano's Fundamentals of Microbiology (10th Edition, 2010) Jeffrey C. Pommerville
2. Atlas, R. M (2nd Edition, 1996) Principles of Microbiology
3. E.C.S. Chan,Michael J. Pelczar, Jr.,Noel R. Krieg (5th Edition, 2001) Microbiology
4. Gornity, G. M (2012) Bergey's Manual of Systematic Bacteriology
5. Madigan, Martinko and Parker (10th Edition, 2002) Brock Biology of Micro-organism
6. Prescott's Microbiology (7th Edition, 2013) Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton
7. Talaro K. and Talaro A. (9th Edition, 2014) Foundations in Microbiology

Course Details			
Course Title: Enzymology			
Course Code	MSBTN2003C04	**Credits**	4
L + T + P	3+ 1+ 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The course is organized by topics which cover many aspects of Enzyme technology, including those that related to animals, microbes, human health, agriculture and the environment. The instructor will introduce each topic and lead the subsequent class discussions.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand working basics of enzymes and their uses in the human life.
- Develop skill for purification of Enzyme and characterization of its catalysis activity with respect to other important factors responsible for its stabilization and function.

- Plan and execute various types of assessments as a teacher in their classes.
- Examine a goodness of Enzymes by establishing reliability and validity, and checking other requirements in our daily life.

Course Contents

UNIT I: Introduction to enzymes (23% Weightage)

Classification and nomenclature. Isolation and purification of enzymes, Enzyme activity, Specific activity and turnover number, Marker enzymes.

UNIT II: Enzyme kinetics (24 % Weightage)

Enzyme Kinetics: Rate of Reaction, Product and Substrate Kinetics, Steady state, pre-steady state, equilibrium kinetics, Michaelis and Menten Equation and its derivation, Different methods to calculate the K_m and V_{max} and their significance.

UNIT III: Enzyme regulation (20 % Weightage)

Factor affecting enzyme activity and catalysis: pH, substrate and enzyme concentration, temperature, coenzyme and cofactors, Catalytic Mechanism of the enzyme. Enzyme inhibition, different types of inhibitors and activators.

UNIT IV: Structure and function of enzymes (18% Weightage)

Structure and Function of Enzymes: Lysozyme, chymotrypsin, RNase. Introduction to allosteric enzymes and isozymes. Industrial Enzymes: Lipase, Protease and Pectinase

UNIT V: Protein and Enzyme Engineering (20% Weightage)

Immobilization of enzymes and their application, RNA-catalysis, Catalytic antibodies - abzymes, Design and construction of novel enzymes, Protein crystallization

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I:Introduction to Enzymes	
1-2	Classification and nomenclature
3-5	Isolation and purification of enzymes
6	Enzyme activity
7-8	Specific activity and turnover number
9-10	Marker enzymes
Unit II: Enzyme Kinetics	
11	Rate of Reaction
12-13	Product and Substrate Kinetics
14-16	Steady state, pre-steady state, equilibrium kinetics
17-19	Michaelis and Menten Equation and its derivation
20-21	Different methods to calculate the K_m and V_{max} and their significance
Unit III: Enzyme Regulation	
22-23	Factor affecting enzyme activity and catalysis: pH, substrate and enzyme concentration, temperature
24	Coenzyme and cofactors
25-26	Catalytic Mechanism of the enzyme and different types of inhibitors and activators

27-30	Enzyme inhibition (Competitive, noncompetitive, uncompetitive, mixed, substrate and partial)
Unit IV: Structure and Function of Enzymes	
31-34	Structure and Function of Enzymes: Lysozyme, chymotrypsin, RNase
35-36	Introduction to allosteric enzymes and its kinetics
37	Isozymes
38	Industrial Enzymes: Lipase, Protease and Pectinase
Unit V: Protein and Enzyme Engineering	
39-40	Immobilization of enzymes and their application
41	RNA-catalysis
42	Catalytic antibodies - abzymes
43	Design and construction of novel enzymes
44-45	Protein crystallization
15 Hours	*Tutorials*

Suggested References:

1. Copeland (2000) Enzyme Kinetics, 2nd edition, Wiley-VCH
2. Kulkarni & Deshpande (2007) General Enzymology, Himalya Publishing House
3. Marangoni A.G (2008) Enzyme Kinetics, a modern approach, Wiley-VCH
4. Palmer (2008) Enzyme Kinetics, Portland Press.
5. Reymond, J-L (2006) Enzyme Assays, Wiley-VCH
6. IUPAC Enzyme nomenclature series (2003).

Course Details			
Course Title: Biology of Immune System			
Course Code	MSBTN2004C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To introduce students about the exciting and challenging field of Immunology with theoretical and practical applications.
- To provide basic and advanced academic training in modern cellular and molecular immunology
- To train students with emphasis on the interface between the basic and clinical aspects of the subject, developing investigative and presentational skills as well.
- The students get exposed to a wide range of immunological topics during lectures and assignments.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand basics of immunology, various immune cells.
- Gain knowledge about different immunological diseases with their causes.
- Understand cytokine biology and how the cytokines network interferes with the immune system
- Think about different therapeutic approaches for combating these immunological diseases.
- Know about different aspects of applied immunology.

Course Contents

Unit-I: Introduction (25% Weightage)

Phylogeny of Immune system, innate and acquired immunity, Clonal nature of immune response. Hematopoiesis and differentiation, Organization and structure of lymphoid organs. Nature and Biology of antigens and super antigens, adjuvants, mitogens.

Unit-II: Antibody (20% Weightage)

Structure and function, antigen and antibody interactions, affinity maturation, molecular mimicry, antibody engineering, Major histocompatibility complex - general organization, inheritance, polymorphism and regulation, generation of antibody diversity and complement system.

Unit-III: Cells of immune system (15% Weightage)

Lymphocyte trafficking, B-lymphocyte, T-lymphocytes, BCR, TCR, γδ TCR, monocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, basophils, neutrophils and mast cells. Activation of B and T- lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.

Unit IV: Immune responses (20% Weightage)

Antigen processing and presentation, generation of humoral and cell mediated immunity, cytokines and their role in immune regulation, T-cell regulation, Immunological tolerance, Hypersensitivity, Autoimmunity, Immonosenescence.

Unit V: Aspects of Immunology (20% Weightage)

Transplantation, Immunity to infectious agents (intracellular parasites, helminths & viruses) Tumor Immunology, AIDS and other immunodeficiencies, Animal models and transgenic animals and their use in immunology.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	Unit/Topic/Sub-Topic
	Unit-I: Introduction
1	Phylogeny of Immune system
2-3	Innate and acquired immunity
4-5	Clonal nature of immune response
6-7	Hematopoiesis and differentiation
8-9	Organization and structure of lymphoid organs
10	Nature and Biology of antigens and super antigens

11	Adjuvants, mitogens
	Unit-II: Antibody
12-13	Structure and function
14	Antigen and antibody interactions
15	Affinity maturation
16	Molecular mimicry, antibody engineering
17	Major histocompatibility complex - general organization, inheritance, polymorphism and regulation
18	Generation of antibody diversity
19	Complement system
	Unit-III: Cells of immune system
20	Lymphocyte trafficking
21	B-lymphocyte, T-lymphocytes
22	BCR, TCR, γδ TCR
23	Monocytes, macrophages, dendritic cells
24	Natural killer and lymphokine activated killer cells
25	Eosinophils, basophils, neutrophils and mast cells
26	Activation of B and T- lymphocytes
27	Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.
	Unit IV: Immune responses
28-30	Antigen processing and presentation
31	Generation of humoral and cell mediated immunity
32	Cytokines and their role in immune regulation
33	T-cell regulation
34	Immunological tolerance
35	Hypersensitivity
36	Autoimmunity
37	Immonosenescence
	Unit V: Aspects of Immunology
38	Transplantation
39-40	Immunity to infectious agents (intracellular parasites, helminths & viruses)
41	Tumor Immunology
42-43	AIDS and other immunodeficiencies
44-45	Animal models and transgenic animals and their use in immunology
15 Hours	*Tutorials*

Suggested References:

6) Kindt T. J., Osborne B. A. and Goldby R. A. (2013) Kuby Immunology, 7th Edition.
7) Delves P., Martin S., Burton D. and Roitt I (2011) Roitt's Essential Immunology (Essentials), 12th Edition.
8) Murphy K. (2011) Janeway's Immunobiology, 8th Edition.
9) Price C. P. and Newman D. J. (1997) Principles and Practice of Immunoassay, 2nd Sub Edition

Course Details			
Course Title: Lab 2 related to MSBTN2001C04+ MSBTN2002C04			
Course Code	MSBTN2005C04	**Credits**	4
L + T + P	0 + 1 + 3	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	15 (T) + 90 (P) Hours
Methods of Content Interaction	Tutorials, Hands-on; self-study, seminar, presentations by students, individual and group performance of experiment.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The main aim of this practical course is to train students a variety of experimental techniques, all of which are currently used in biotechnology research. The practicals have been designed to complement the lectures and fit in with their sequence as far as possible. The hands-on experience should link to the mental framework provided by the lectures, and give students a deeper understanding and more realistic perspective of the topics discussed.

Learning Outcomes

After completion of the course the learners will be able to:

Students will be able to learn to handle and analyze the molecular biology experimental data effectively, and to extract the information contents from the data. The objective of this course is to introduce students with practical hands for the cultivation of Bacteria/Sterile Technique, pure culture technique and finally identification of an unknown microorganism by advanced molecular biology techniques.

Course Contents

UNIT I: MSBTN2001C04: Molecular Biology & Genomics (50% Weightage)

Experiment 1: Competent cells preparation
Experiment 2: Transformation
Experiment 3: Plasmid isolation from *E. coli*
Experiment 4: Agarose gel electrophoresis
Experiment 5: Total genomic DNA isolation from blood
Experiment 6: Restriction digestion

UNIT II: MSBTN2002C04: Microbiology (50 % Weightage)

Experiment 1: Preparation of nutrient agar medium for the culture of soil bacteria/air/water
Experiment 2: To isolate pure culture of bacteria from soil/air/water sample by serial dilution and spreading method
Experiment 3: Determine the Gram stain of bacterial sample
Experiment 4: Isolation of bacterial genomic DNA
Experiment 5: To separate and visualize DNA bands by agarose gel electrophoresis
Experiment 6:PCR amplification of 16s rDNA region of extracted genomic DNAfrom bacteria

Content Interaction Plan:

Practical cum Discussion (Each session of 3 Hour)	**Unit/Topic/Sub-Topic**
Unit I	**Molecular Biology & Genomics**
1-9	Experiment 1
10-12	Experiment 2
13-21	Experiment 3
22-30	Experiment 4
31-39	Experiment 5
40-45	Experiment 6
Unit II	**Microbiology**
1-9	Experiment 1
10-18	Experiment 2
19-24	Experiment 3
25-36	Experiment 4
37-39	Experiment 5
40-45	Experiment 6
15 Hours	*Tutorials*

- Suggested References:

1. Molecular Biology and Biotechnology by MP Bansal published by TERI
2.Experiments in Microbiology, Plant Biotechnology and Biotechnology by KR Aneja, New age international publisher 2012
3. Techniques in Life sciences by DB Tembhare, Himalaya publishing house, 2017
4. Methods for Preparation and Screening of r-DNA by N. Srivastava and A. Kumar, University Science press.

Course Details			
Course Title: Lab 3 related to MSBTN2003C04+ MSBTN2004C04			
Course Code	MSBTN2006C04	**Credits**	4
L + T + P	0 + 1 + 3	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	15 (T) + 90 (P) Hours
Methods of Content Interaction	Tutorials, Hands-on; self-study, seminar, presentations by students, individual and group performance of experiment.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- The objective of this course is also to teach concepts and principles of various experiments commonly conducted for Enzymology. This course covers methods

for the isolation, purification, optimization and characterization of proteins, enzyme kinetics; and production conditions.

- The aims of this applied immunology laboratory course is to equip students with a good understanding of major immunological laboratory techniques (including safety) and their applications to both clinical analysis and experimental research. Research principles, quantitative reasoning, and understanding of immunological research methodologies will be highlighted within the course. Special attention is given to the experimental approaches that led to the general principles of immunology.

Learning Outcomes

After completion of the course the learners will be able to:

- This practical course will teach the students various practicals related to enzymology, enzyme technology and Immunology.
- They will be able to learn various methods used in enzyme kinetics and about immunodiagnostic techniques.
- The students will develop skills to distinguishing different characteristics of a variety of techniques used in clinical Immunology
- They will be able to learn various methods used in enzyme kinetics and about immunodiagnostic techniques.

Course Contents

UNIT I: MSBTN2003C04: Basic Enzymology (40% Weightage)

Experiment 1: Isolation of protease enzyme from *E.coli*
Experiment 2: Estimation of protein concentration using Lowry's method
Experiment 3: To measure the ATPase enzyme and specific activity of the given enzyme sample
Experiment 4: To prepare standard curve of inorganic phosphate
Experiment 5: To immobilize the given enzyme using calcium alginate method
Experiment 6: To determine the enzyme activity of the immobilized sample

UNIT II: MSBTN2004C04: Biology of Immune System (60 % Weightage)

Experiment 1: Separation of plasma from blood.
Experiment 2: Separation of serum from blood.
Experiment 3: Identification and estimation of the percentage of live and dead cells in the blood sample using Trypan Blue.
Experiment 4: Lysis of RBC in the blood sample.
Experiment 5: Estimation of the percentage of live and dead WBCs in the blood sample after RBC lysis using Trypan Blue.
Experiment 6: Counting of RBCs and WBCs using Haemocytometer.
Experiment 7: Isolation of lymphocytes using Histopaque and counting using Haemocytometer.
Experiment 8: Differential staining of cells in the blood sample using Wright-Giemsa staining method.
Experiment 9: Determination of antigen or antibody by Radial Immuno diffusion
Experiment 10: Determination of antibody titration Ouchterlony Double Diffusion
Experiment 11: Determining antibody/antigen/cytokine by ELISA/Dot ELISA.
Experiment 12: To observe the phagocytosis process in macrophages.
Experiment 13: Demonstration of dissection to show different lymphoid organs in mouse (Computer technology).
Experiment 14: WBC/T cell culture work

Content Interaction Plan:

Practical cum Discussion (Each session of 3 Hour)	**Unit/Topic/Sub-Topic**
Unit I	**Basic Enzymology**
1-6	Experiment 1
7-9	Experiment 2
10-15	Experiment 3
18-24	Experiment 4
24-30	Experiment 5
31-36	Experiment 6
Unit II	**Biology of Immune System**
1-3	Experiment 1: Separation of plasma from blood.
4-6	Experiment 2: Separation of serum from blood.
7-9	Experiment 3: Identification and estimation of the percentage of live and dead cells in the blood sample using Trypan Blue.
10-15	Experiment 4: Lysis of RBC in the blood sample.
16-18	Experiment 5: Estimation of the percentage of live and dead WBCs in the blood sample after RBC lysis using Trypan Blue.
19-24	Experiment 6: Counting of RBCs and WBCs using Haemocytometer.
25-27	Experiment 7: Isolation of lymphocytes using Histopaque and counting using Haemocytometer.
28-33	Experiment 8: Differential staining of cells in the blood sample using Wright-Giemsa staining method.
34-36	Experiment 9: Determination of antigen or antibody by Radial Immuno diffusion.
37-39	Experiment 10: Determination of antibody titration Ouchterlony Double Diffusion.
40-42	Experiment 11: Determining antibody/antigen/cytokine by ELISA/Dot ELISA.
43-45	Experiment 12: To observe the phagocytosis process in macrophages.
46-48	Experiment 13: Demonstration of dissection to show different lymphoid organs in mouse (Computer technology).
49-54	Experiment 14: WBC/T cell culture work.
15 Hours	*Tutorials*

- Suggested References:

1. Practical Immunology, 4th Edition by Frank C. Hay (Author), Olwyn M. R. Westwood (Author), Wiley-Blackwell
2. Clinical Immunology and Serology: A Laboratory Perspective Paperback – Import, 1 Aug 2003, by Christine Dorresteyn Stevens (Author), F.A. Davis Company

THIRD SEMESTER

Course Details			
Course Title: Recombinant DNA Technology			
Course Code	MSBTN3001C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- The main objective of this course is to present an in-depth understanding of recombinant DNA technology as the foundation of modern biotechnology and to show how its tools can be employed in the guided production of goods and services.
- Learning objectives include outlining the process of molecular cloning of a gene or segment of DNA, choosing the most appropriate technique for cloning eukaryotic genes, comparing and contrasting the vectors and procedures used for creating genetically modified bacteria, plants and animals.

Learning Outcomes

This shall be served tool to improve understanding of the genetic basis for life has opened up approaches to the investigation, diagnosis and treatment of diseases.

Course Contents

UNIT I: (25% Weightage)

Isolation of DNA and RNA, Quantification of nucleic acids. Radiolabelling and non-radiolabelling of nucleic acids: End labelling, nick translation, labelling by primer extension, DNA sequencing: Maxam-Gilbert and Sanger- Nicolson sequencing methods, Pyrosequencing, Automated gene sequencing, Protein Sequencing.

UNIT II: (25 % Weightage)

Restriction-Modification System: Types of restriction endonucleases, classification and their application; Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and DNA ligases, Kinases; Cutting and Joining of DNA Fragments, cohesive and blunt end ligation, adaptors, linkers/polylinkers and homo polymer tailing.

UNIT III: (20 % Weightage)

Plasmid vectors: properties and construction of cosmid and artificial plasmids, Bacteriophage λ as cloning vector, other prokaryotic vectors, expression vectors, Difference in cloning and expression vectors. Use of strong promoters.

UNIT IV: **(20% Weightage)**

Cloning Strategies, Construction of Genomic and cDNA libraries, Selection, screening and analysis of recombinants. Principle of hybridization. Southern blotting, Northern blotting, Western blotting. Polymerase chain reaction.

UNIT V: **(10% Weightage)**

Methods used to transfer rDNA in host: Application of RDT in medicine and agriculture. DNA Finger printing.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	
1-3	Isolation of DNA and RNA, Quantification of nucleic acids
4-5	Isolation of DNA and RNA
6-7	Radiolabelling and non-radiolabelling of nucleic acids: End labelling, nick translation, labelling by primer extension
8-9	DNA sequencing: Maxam-Gilbert and Sanger- Nicolson sequencing methods
10-12	Pyrosequencing, Automated gene sequencing, Protein Sequencing
Unit II	.
13-14	Restriction-Modification System: Types of restriction endonucleases, classification and their application
15-16	DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and DNA ligases, Kinases
17-20	Cutting and Joining of DNA Fragments, cohesive and blunt end ligation, adaptors, linkers/polylinkers and homo polymer tailing
Unit 3	
21-22	Plasmid vectors: properties and construction of cosmid and artificial plasmids
23-25	Bacteriophage λ as cloning vector, other prokaryotic vectors, expression vectors
26	Difference in cloning and expression vectors. Use of strong promoters
Unit 4	
27-29	Cloning Strategies, Construction of Genomic and cDNA libraries
29	Selection, screening and analysis of recombinants
30-32	Principle of hybridization: Southern blotting, Northern blotting
33-34	Western blotting
35-37	Polymerase chain reaction.
Unit 5	
38-39	Methods used to transfer rDNA in host
40-44	Application of RDT in medicine and agriculture

45	DNA Finger printing
15 Hours	*Tutorials*

- Suggested References:

1. Principles of Gene manipulation and Genomics (2006) S. B. Primrose and R. M. Twyman. 7th edition
2. From Genes to Clones (2010) Winnaeker E.L. 4th edition
3. Recombinant DNA (2007) Watson J.D., Witreowski J., Gilman M. and Zooller M. 2nd edition
4. An Introduction to Genetic Engineering: Nicholl, D.S.T.3rd edition
5. Molecular Biotechnology (2002) Pasternak. 4th edition
6. The Biochemistry of Nucleic acid (2008) Adam et al. 11th edition
7. Genetic Engineering (2006) Janke K. Swtlow

Course Details			
Course Title: BIOPROCESS ENGINEERING			
Course Code	MSBTN3002C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To get a thorough knowledge of all the unit operations of upstream and downstream processing involved in fermentation processes.
- To introduce the basic concepts of process engineering, including fluid flow, heat and mass transfer and their applications in various process developments.
- To design appropriate sterilization method, choosing a proper enzyme system and corresponding bioreactor.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will learn the importance of engineering in the bioprocess.
- Students will have the concept of scaling up i.e. from lab to industry.
- They will know the techniques involved to get the purified products after fermentation.
- Student will get the idea about the production of drugs, antibiotics and factors affecting the production of these products.

Course Contents

UNIT I: Kinetics of microbial growth (20% Weightage)

Introduction to bioprocess engineering, Microbial growth and products formation, media formulation for industrial fermentation, Media optimization and sterilization, Mass balance in biotechnology.

UNIT II: Aeration and agitation (20 % Weightage)
Oxygen requirement, Volumetric oxygen transfer rate, Oxygen uptake rate, Degree of oxygen satisfaction, Types of impellers and spargers, Foam formation and control

UNIT III: Fermentation Techniques (20 % Weightage)
Types and modes of cultivation (batch, fed batch and continuous bioreactions), Measurement and control of bioprocess parameters, Microbial and plant bioreactors, Different types of bioreactors-CSTR, airlift bioreactor, packed bed, fluidized, photobioreactors, enzyme reactors, Design, stability and analysis of reactors

UNIT IV: Scale up techniques (20% Weightage)
Introduction, Bases of scale-up, Physical concept and biological concept, Scale-up methods in use, Examples of scale-up: Power per unit volume of liquid and volumetric oxygen transfer coefficient, Introductory comments on non-Newtonian fluids.

UNIT V: Downstream Processing (20% Weightage)
Introduction, Removal of microbial cells and solid matters, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, Membrane process, Crystallization and drying.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	***Kinetics of Microbial Growth***
1	Introduction to bioprocess engineering
2-3	Kinetics of microbial growth
4-5	Kinetics of products formation
6	Media formulation for industrial fermentation and Media optimization
7-8	Media sterilization and kinetics of thermal death, Design criteria
9	Mass balance and Stiochiometric calculation
Unit II	***Aeration and Agitation***
10	Oxygen transfer from gas bubble to cell
11-12	Volumetric oxygen transfer rate and K_La
13	Oxygen uptake rate and critical value of dissolved oxygen concentration (degree of oxygen satisfaction)
14-15	Dynamic and static method for K_La and parameters on which K_La depend
16	Types of impellers and spargers, Foam formation and control
17-18	Stirrer Power requirement (Ungassed and Gassed Newtonian liquid)
Unit 3	***Fermentation Techniques***
19	Introduction to batch, fed batch and continuous bioreactors
20	Concept of chemostat and turbidostat
21-22	Steady state continuous cultivation theory for substrate, cell mass and product
23-24	Design criteria with concept of Wash-out phenomenon
25	Concept of fed batch operation

26	Design, stability and analysis of reactors, Measurement and control of bioprocess parameters
27	Microbial and plant bioreactors, different types of bioreactors- CSTR, airlift bioreactor, packed bed, fluidized, photobioreactors, enzyme reactors,
Unit 4	***Scale up Techniques***
28	Bases of scale-up
29-30	Physical concept and biological concept
31	Scale-up methods in use
32-33	Power per unit volume of liquid
34-35	Volumetric oxygen transfer coefficient
36	Introductory comments on non-Newtonian fluids
Unit 5	***Downstream Processing***
37	Introduction, removal of microbial cells and solid matters, foam separation
38-39	Filtration
40	Centrifugation
41	Cell disruption,
42	Liquid-liquid extraction
43	Precipitation
44	Membrane process (dialysis, reverse osmosis and ultrafiltration)
45	Chromatography, crystallization and drying
15 Hours	*Tutorials*

- Suggested References:

1. Bailey, James E, Ollis, David F (2010) Biochemical engineering fundamentals. 2nd edition, Tata McGraw Hill Education (New Delhi).
2. Biotol Series (2007) Product recovery in bioprocess technology, 3rd edition, Butterworth-Heinemann, New Delhi.
3. Crueger W, Crueger A (2008) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
4. Doran P. M, (2010) Bioprocess engineering principles. 2nd edition, Academic Press (New Delhi).
5. Glaser A. N, Nilaido.H (2011) Microbial Biotechnology,2nd edition, W.H Freeman and Co.
6. Shuler, M. L., Kargi, F. (2009) Bioprocess engineering basic concepts. 2nd edition, Pearson (New Delhi).
7. Stanbury P.F, Ehitaker H, Hall S.J (2006) Principles of Fermentation Technology, 2nd edition, Aditya Books (P) Ltd
8. Sullia S. B, Shantharam S: (2010) General Microbiology, 2nd edition, Oxford and IBH Publishing Co. Pvt.Ltd.
9. Vogel H. C, Todaro C. L (2008) Fermentation and biochemical engineering handbook, 2nd ed., Wiley Publishing, Hoboken

Course Details			
Course Title: ANIMAL BIOTECHNOLOGY			
Course Code	MSBTN3003C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To develop competence in the areas of animal biotechnology to improve animal growth and reproduction.
- To have a comprehensive understanding of animal tissue culture, Stem cell research, transgenic techniques and biotechnological applications.
- To understand the use of biotechnological applications in health, medicine and industries.

Learning Outcomes

- To make an association between animal and human health with development of technology.
- To understand how to modify physiological processes to obtain biotechnological products to be applied to agricultural, social and medical areas.
- To develop career in biotechnology research relevant to animal health and medicine.

Course Contents

UNIT I: Animal Tissue/cell culture (20% Weightage)

History of animal cell culture, Different types of cell cultures: Development of cell lines Primary and Continuous cell cultures, Cell culture media: media composition, serum, antibiotics, supplements, physiochemical properties, Cell culture laboratory setup and instrumentation.

UNIT II: Cell culture techniques (20 % Weightage)

Cell separation methods, characterization and maintenance of cell lines. Trypsinization, cryopreservation. Common cell culture contaminants. Good Laboratory Practices

UNIT III: Stem cell research (20 % Weightage)

Different types of stem cells. Stem cell culture, stem cell differentiation, current status and application in medicine. Embryo culture, somatic cell nuclear transfer (SCNT), IVF. Artificial blood.

UNIT IV: Gene transfer technology in animals (20% Weightage)

Viral and non-viral methods, Production and status of transgenic animals, molecular pharming, Animal & Human cloning: Techniques, relevance and ethical issues.

UNIT V: Application of cell culture technology (20% Weightage)

Production of human and animal vaccines and pharmaceutical proteins. Molecular diagnostics: techniques and relevance, detection of animal pathogen in environmental systems, animal imaging, molecular medicine, isotopes and their usage in diagnosis and therapy.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
UNIT I: Animal Tissue/Cell Culture	
1-5	History of animal cell culture, Different types of cell cultures: Development of cell lines Primary and Continuous cell cultures,
6-9	Cell culture media: media composition, serum, antibiotics, supplements, physiochemical properties, Cell culture laboratory setup and instrumentation.
UNIT II: Cell Culture Techniques	
10-14	Cell separation methods, characterization and maintenance of cell lines.
15-18	Trypsinization, cryopreservation. Common cell culture contaminants. Good Laboratory Practices
UNIT III: Stem Cell Research	
19-23	Different types of stem cells. Stem cell culture, stem cell differentiation.
24-27	Current status and application in medicine. Embryo culture, somatic cell nuclear transfer (SCNT), IVF. Artificial blood.
UNIT IV: Gene transfer technology in animals	
28-33	Viral and non-viral methods, Production and status of transgenic animals, molecular pharming,
34-36	Animal & Human cloning: Techniques, relevance and ethical issues.
UNIT V: Application of cell culture technology	
37-40	Production of human and animal vaccines and pharmaceutical proteins. Molecular diagnostics: techniques and relevance,
41-45	Detection of animal pathogen in environmental systems, animal imaging, molecular medicine, isotopes and their usage in diagnosis and therapy.
15 Hours	**Tutorials**

Suggested References:

- Freshney, I. R. (2010). Culture of Animal Cells, 5th Edition, Wiley-Liss.
- Masters, J.R.W.(2000). Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press,
- Clynes, M. (2008) Animal Cell Culture Techniques., Springer.
- Hafez, B., Hafez, E.S.E. (2010) Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell. Turksen, K. 2004. Adult Stem Cells. Humana

Press, Inc.
- Thomson, J et al. 2004. Handbook of Stem Cells: Embryonic/ Adult and Fetal Stem cells (Vol. 1 & 2). Academic Press.
- Houdebine, L.M. (2010). Transgenic Animals: Generation and Use, 1st Edition, CRC Press

Course Details			
Course Title: Plant Biotechnology			
Course Code	MSBTN3004C04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- The main objectives of this course is to introduce students to the principles, practices and applications of plant tissue culture, genetic transformation and molecular marker development in science, agriculture and industry.
- The students will also be exposed to the issues and challenges encountered in the area of plant biotechnology.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will learn the importance of plant tissue culture, genetic transformation and molecular marker development.
- Students will have the concept of development of transgenic plant.
- They will know the techniques involved molecular marker development.

Course Contents

UNIT I: Introduction to plant tissue culture techniques (20% Weightage)

Introduction to the techniques of plant tissue culture. Concept of cellular totipotency. Media composition and sterilization techniques, Plant propagation: Regeneration through meristem and callus cultures; Somatic embryogenesis: production, preservation and use of somatic embryos as propagules; Embryo culture; Haploid plant production; Protoplast culture; Somatic hybridization; Artificial Seeds; Germplasm conservation

UNIT II: Plant transformation techniques (20 % Weightage)

Basis of tumor formation; Hairy root; Features of Ti and Ri plasmids; Mechanisms of DNA transfer; Role of virulence genes; Use of Ti and Ri as vectors; Binary vectors; Use of 35S and other promoters; Methods of nuclear transformation; Viral vectors and their applications; Multiple gene transfers; Vector-less or direct DNA transfer; Particle bombardment, electroporation, microinjection; Chloroplast transformation; Transgene stability and gene silencing.

UNIT III: Application of plant transformation for productivity and performance (20 % Weightage)
Insect resistance, Fungal diseases resistance, Bacterial diseases resistance, herbicide Resistance, Drought and salt resistance.

UNIT IV: Molecular markers in plant genome analysis (20% Weightage)
Introduction to the Principle of Molecular marker. Types of molecular markers and its application: RAPD, RFLP, AFLP, microsatellites, Simple Sequence Repeats (SSR's), Sequence-Tagged Sites (STSs), Sequence Characterized Amplified Regions (SCAR), Single Strand Conformational Polymorphism (SSCP), Cleaved amplified polymorphic sequences (CAPs).

UNIT V: Plant secondary metabolites (20% Weightage)
Control mechanisms and manipulation of alkaloids and industrial enzymes, Plant derived biodegradable plastics, Edible vaccines.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	***Introduction to plant tissue culture techniques***
1	Introduction to the techniques of plant tissue culture
2-3	Concept of cellular totipotency. Media composition and sterilization techniques
4-5	Plant propagation: Regeneration through meristem and callus cultures
6	Somatic embryogenesis: production, preservation and use of somatic embryos as propagules; Embryo culture
7-8	Haploid plant production; Protoplast culture; Somatic hybridization
9	Artificial Seeds; Germplasm conservation
Unit II	***Plant transformation techniques***
10	Basis of tumor formation; Hairy root; Features of Ti and Ri plasmids
11-12	Mechanisms of DNA transfer; Role of virulence genes; Use of Ti and Ri as vectors
13	Binary vectors; Use of 35S and other promoters; Methods of nuclear transformation
14-15	Viral vectors and their applications; Multiple gene transfers; Vector-less or direct DNA transfer
16	Particle bombardment, electroporation, microinjection
17	Chloroplast transformation
18	Transgene stability and gene silencing
Unit 3	***Application of plant transformation for productivity and performance***
19	Insect resistance,
20	Fungal diseases resistance
21-22	Bacterial diseases resistance
23-24	herbicide Resistance
25-27	Drought and salt resistance

Unit 4	***Molecular markers in plant genome analysis***
28	Introduction to the Principle of Molecular marker
29-30	Types of molecular markers and its application: RAPD, RFLP, AFLP, microsatellites, Simple Sequence Repeats (SSR's)
31	Sequence-Tagged Sites (STSs), Sequence Characterized Amplified Regions (SCAR)
32-33	Single Strand Conformational Polymorphism (SSCP)
34-36	Cleaved amplified polymorphic sequences (CAPs)
Unit 5	***Plant secondary metabolites***
37-39	Control mechanisms and manipulation of alkaloids
40-42	Industrial enzymes
43	Plant derived biodegradable plastics
44-45	Edible vaccines
15 Hours	*Tutorials*

Suggested References:

1. Aneja KR (5th Edition, 2017) Experiment in Microbiology, Plant pathology and Tissue Culture
2. Charles Neal Stewart, Alisher Touraev, Vitaly Citovsky, Tzvi Tzfira (2010) Plant Transformation Technologie
3. Dunwell, Jim M., Wetten, Andy C (20102) Transgenic Plants
4. Razdan MK (2008) Introduction To Plant Tissue Culture
5. Razdan MK, Bhojwani SS (4th Edition, 2009) Plant Tissue Culture
6. Taiz L, Zeiger E (4th Edition, 2010) Plant Physiology

Course Details			
Course Title: Lab 4 related to MSBTN3001C04+ MSBTN3002C04			
Course Code	MSBTN3005C04	**Credits**	4
L + T + P	0 + 1 + 3	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	15 (T) + 90 (P) Hours
Methods of Content Interaction	Tutorials, Hands-on; self-study, seminar, presentations by students, individual and group performance of experiment.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

The objective of Recombinant DNA Technology is to familiarize the students with all recent practical tools and techniques required for creating a recombinant DNA molecule and transforming the appropriate host cell to check the expression of recombinant DNA. There will be description of how agarose gel electrophoresis, restriction enzyme mapping, and DNA sequencing can be used to study gene structure. And the common techniques used to study gene expression will be explained.

This course also covers the concepts and principles of various experiments commonly conducted for Bioprocessing Engineering such as growth curve leading to the calculation of various parameters. Also the experiments related to the isolation of protein and secondary metabolite will be carried out.

Learning Outcomes

After completion of the course the learners will be able to:

The students will be able to compare and contrast different types of vectors and describe practical features of vectors and their applications in molecular biology. They will learn how DNA libraries are created and screened to clone a gene of interest.

In bioprocess experiment, the student will learn about the various external and internal factors such as temperature affecting the fermentation process.

Course Contents

UNIT I: MSBTN3001C04: Recombinant DNA Technology (50% Weightage)

Experiment 1: Total RNA isolation from Cell line/Tissue
Experiment 2: cDNA Preparation
Experiment 3: PCR
Experiment 4: Ligation
Experiment 5: Transformation
Experiment 6: Identification of expressed protein

UNIT II: MSBTN3001C04: Bioprocess Engineering (50 % Weightage)

Experiment 1: Growth curve and different phases of growth curve
Experiment 2: Specific growth rate from the growth curve
Experiment 3: Doubling time from the growth curve
Experiment 4: Thermal death constant and thermal reduction time
Experiment 5: Extraction of soy protein from soy flour
Experiment 6: Microbial degradation of aromatic compounds
Experiment 7: Isolation of antimicrobial secondary metabolite from fungal culture
Experiment 8: To calculate MIC 50 of the given antimicrobial compound

Content Interaction Plan:

Practical cum Discussion (Each session of 3 Hour)	**Unit/Topic/Sub-Topic**
Unit I	**Recombinant DNA Technology**
1-9	Experiment 1
10-12	Experiment 2
13-18	Experiment 3
19-27	Experiment 4
28-30	Experiment 5
31-45	Experiment 6
Unit II	**Bioprocess Engineering**
1-9	Experiment 1
10-12	Experiment 2
13-15	Experiment 3
16-21	Experiment 4
22-24	Experiment 5
25-30	Experiment 6
31-39	Experiment 7
40-45	Experiment 8
15 Hours	*Tutorials*
• Suggested References:	

1) Bailey, James E, Ollis, David F (2010) Biochemical engineering fundamentals. 2nd edition, Tata McGraw Hill Education (New Delhi).
2) Biotol Series (2007) Product recovery in bioprocess technology, 3rd edition, Butterworth-Heinemann, New Delhi
3) Methods for preparation and screening of rDNA by N. Srivastava and Arun kumar, University Science Press.

Course Details			
Course Title: Lab 5 related to MSBTN3003C04+ MSBTN3004C04			
Course Code	MSBTN3006C04	**Credits**	4
L + T + P	0 + 1 + 3	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	15 (T) + 90 (P) Hours
Methods of Content Interaction	Tutorials, Hands-on; self-study, seminar, presentations by students, individual and group performance of experiment.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To promote transferable skills, such as critical thinking and systematic problem solving skills.
- To familiarize the students with all practical tools and techniques required for practical applications of the exciting field of animal and plant biotechnology.
- To develop interest in this upcoming area useful in health and agriculture sector for academics, research and future entrepreneurship.

Learning Outcomes

- To understand the methods used in routine animal and plant cell culture practices in biological, agriculture and pharma industries.
- Would be able to carry out future research involving animal and plant tissue culture.
- To be able to compete in various training based programmes providing financial support. (i.e. Biotech Consortium of India Limited, BCIL)
- Take up independent career in biotechnology field.

Course Contents

UNIT I: MSBTN3003C04: Animal Biotechnology (50% Weightage)

Experiment-1: Adherent and non-adherent animal cell culture.
Experiment-2: Cell trypsinization, sub culturing, cryopreservation.
Experiment-3: Live and dead cell assay by trypan blue method.
Experiment-4: Cellular proliferation and cytotoxicity assay by MTT method.
Experiment-5: To study the cell death by apoptotic assay.
Experiment-6: To study the effect of oxidative stress on viability of cell line animal cell line.
Experiment-7: Transfection of animal cell line (optional)
Experiment-8: Analysis of expressed proteins through western blotting/microscopy.

UNIT II: MSBTN3004C04: Plant Biotechnology (50 % Weightage)

Experiment-1: Preparation of stock solutions of MS (Murashige & Skoog, 1962) basal medium

Experiment-2: To prepare MS media with different concentration of 6- Benzyl amino purine (BAP) for regeneration from leaf of Tobacco

Experiment-3: Surface sterilization and inoculation of tobacco leaf explants on MS medium for shoot regeneration.

Experiment 4: Isolation of plant genomic DNA by modified CTAB method

Experiment 5: To perform DNA fingerprinting by random amplification of polymorphic DNA (RAPD) technique by PCR

Content Interaction Plan:

Practical cum Discussion (Each session of 3 Hour)	**Unit/Topic/Sub-Topic**
Unit I: Animal Biotechnology (45 hrs)	
1-9	Experiment 1: Adherent and non-adherent animal cell culture.
10-15	Experiment-2: Cell trypsinization, sub culturing, cryopreservation.
16-18	Experiment-3: Live and dead cell assay by trypan blue method.
19-24	Experiment-4: Cellular proliferation and cytotoxicity assay by MTT method.
25-30	Experiment-5: To study the cell death by apoptotic assay.
31-36	Experiment-6: To study the effect of oxidative stress on viability of cell line animal cell line.
37-45	Experiment-7: Transfection of animal cell line (optional) Experiment-8: Analysis of expressed proteins through western blotting/microscopy.
Unit II: Plant Biotechnology	
1-6	Experiment 1
7-12	Experiment 2
13-15	Experiment 3
16-28	Experiment 4
29-45	Experiment 5
15 Hours	**Tutorials**

Suggested References:

Animal Biotechnology:

1. Freshney, I. R. (2010). Culture of Animal Cells, 5th Edition, Wiley-Liss.
2. Masters, J.R.W.(2000). Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press,
3. Clynes, M. (2008) Animal Cell Culture Techniques. Springer.

FOURTH SEMESTER

Course Details			
Course Title: Project Dissertation, Presentation and Comprehensive *Viva-voce*			
Course Code	MSBTN4001C16	**Credits**	16
L + T + P	0 +2 + 14	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	30 (T) + 420 (P)
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

 # The student has the option to carry out the dissertation work outside the university provided he gets it on his own. However, they have to follow the academic calendar of the parent University. In case, the student does not get the dissertation work outside the University they will be accommodated for the dissertation work in the Dept. of Biotechnology. Students will be allotted as per the system so as to maintain uniformity and non-biasness.

Course Objectives

As partial requirement for the Award of M.Sc. Degree in Biotechnology, a project culminating in the submission of a dissertation must normally be carried out by students in their final year of study. The project-dissertation is a component that provides the students with the opportunity to design, undertake or conduct an independent piece of research under the guidance of a supervisor. A 'Project' leads to a 'dissertation' that is assessed. The 'Dissertation' is a comprehensive description of the aims, objectives of the project, a review of the literature on the subject matter, the investigation/planning and methodology, the results and findings, and concrete recommendations and conclusions. Every student will submit a comprehensive report of the project work carried out in previous semesters in the form of dissertation, duly certified by the supervisor appointed by the Head of the Department. The project will be presented by the student and evaluated by external expert at the end of the semester. The students shall be required to present themselves for a comprehensive viva-voce examination before completion of the course.

- A 'Project' is an investigative undertaking, a structured, organized experiential learning including design work, field work or other placement learning.
- The dissertation is a major document that reflects the skills of the student to investigate critically a topic/problem, the ability to gather and analyze information, and to present and discuss the results/investigation concisely and clearly.
- Be a self-motivated and personally responsible for your action and learning
- Apply standard and advance techniques to solve a range of identified problems
- Be proficient in the recording, storage, management and reporting data

Learning Outcomes

After completion of the course the learners will be able to:

- Produced independently conducted a piece of research work
- Gain expertize in particular area of research
- Gain expertize on particular topic of research

- Obtained information from verity of sources and learn the process of evaluation of useful and non-useful information.
- Students will learn the ways to write the thesis.
- Students will construct clear detailed and logical arguments.
- Students will have an idea related to assessment of experimental results and the presentation of data.
- Develop ability to present and defend their research work to a panel of experts.
- Develop ability to publish their research output in high impact journals, conference proceedings and in the form of patents.

Content Interaction Plan:

Practical cum Discussion	**Unit/Topic/Sub-Topic**
420 Hours	In one week student will devote 28 h of experimental work. So in 15 weeks 420 h.
30 Hours	*Tutorials*

ASSESSMENT AND EVALUATION IN BIOTECHNOLOGY FOR ELECTIVES (10/5/2019)

FIRST SEMESTER

Course Details			
Course Title: Biodiversity and Ecobiotechnology			
Course Code	MSBTN1001E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This *course* is an introduction to biodiversity and its conservation strategies, environment and types of pollution present in the *universe.*
- *It* focuses on the utilization of microbial processes in waste and water treatment, biodegradation of petroleum products and bioremediation.
- On successful completion of the *course* the student will be know the importance of microbial diversity in *environmental* systems, processes and *biotechnology* as well as the importance of molecular approaches in *environmental* microbiology and *biotechnology*.

Learning Outcomes

After completion of the course the learners will be able to:

- Students will learn the importance of Biodiversity and its conservation strategies
- Students will have the concept and importance of ecology.
- They will know the biotechnological techniques involved biodiversity conservation

Course Contents

UNIT I: Introduction about Biodiversity (20% Weightage)

Concept and Principle: History of the Earth and Biodiversity patterns through Geological times; Current Centers of Biodiversity; Concepts of species and hierarchical taxa, biological nomenclature, classical &quantitative methods of taxonomy of plants, animals and microorganisms.

UNIT II: Conservation Strategies (20 % Weightage)

Rare, endangered species. Ex-situ and In situ conservation strategies. Selection criteria for protection of species – species quality, IUCN Guidelines for Red List categories and criteria, Red List of Indian Flora and Fauna, Selection criteria for protection of habitats – hotspots, Conservation indices.

UNIT III: Basics of Ecobiotechnology (20 % Weightage)

Composition of atmosphere, lithosphere, hydrosphere; Ecosystem structure: air, water, soil, primary producers, consumers and decomposers; Ecosystem function : energy flow, food chains, food webs, ecological pyramids & biotic interaction; Concepts of sustainable development.

UNIT IV: Environmental Pollution (20 % Weightage)

Types, Major sources and effects of air pollutants, air borne diseases; Types, major sources and effects of water pollutants, water borne diseases; Types, major sources and effects of soil pollutants; Major sources of noise pollution, effects of noise pollution on health; Types, major sources and effects of radioactive pollutants; Air, water and noise quality standards.

UNIT V: Environmental Biotechnology (20% Weightage)

Waste water collection; Control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques; Bioremediation of organic pollutants and odorous compounds; Biodegradation of petroleum pollutants: Bioaugmentation; Bioremediation of contaminated soils; Bioremediation of contaminated ground water; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries; Biofiltration technologies for pollution abatement, Genetically engineered microbes and environmental risk

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
Unit I	***Introduction about Biodiversity***
1	Concept and Principle
2-3	History of the Earth and Biodiversity patterns through Geological times
4-5	Current Centers of Biodiversity
6	Concepts of species and hierarchical taxa
7--9	Biological nomenclature, classical &quantitative methods of taxonomy of plants, animals and microorganisms
Unit II	***Conservation Strategies***
10	Rare, endangered species
11-12	Ex-situ and In situ conservation strategies
13	Selection criteria for protection of species – species quality
14-15	IUCN Guidelines for Red List categories and criteria
16	Red List of Indian Flora and Fauna
17-18	Selection criteria for protection of habitats – hotspots, Conservation indices
Unit 3	***Basics of Ecobiotechnology***
19	Composition of atmosphere, lithosphere, hydrosphere
20	Ecosystem structure: air, water, soil, primary producers, consumers and decomposers
21-22	Ecosystem function
23-24	Energy flow

25	Food chains
26	Food webs, ecological pyramids & biotic interaction
27	Concepts of sustainable development
Unit 4	***Environmental Pollution***
28	Types of pollution
29-30	Major sources and effects of air pollutants, air borne diseases
31	Types, major sources and effects of soil pollutants
32-33	Major sources of noise pollution
34-36	Effects of noise pollution on health; Types, major sources and effects of radioactive pollutants; Air, water and noise quality standards
Unit 5	***Environmental Biotechnology***
37	Waste water collection
38-39	Control and management; Waste water treatment; Sewage treatment through chemical, microbial and biotech techniques;
40	Bioremediation of organic pollutants and odorous compounds
41	Biodegradation of petroleum pollutants
42	Bioaugmentation; Bioremediation of contaminated soils; Bioremediation of contaminated ground water
43	Phytoremediation of soil metals
44	Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries; Biofiltration technologies for pollution abatement
45	Genetically engineered microbes and environmental risk
15 Hours	*Tutorials*

Suggested References:

1. Van Dyke, F.2008.Conservation Biology Foundations, Concepts, Applications 2nd Edition, Springer.
2. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
3. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. Science Publication.
4. Primack, R. 2006. Essentials of Conservation Biology.Sinauer Associates, Inc., USA.
5. Hambler, C. 2004. Conservation. Cambridge University Press.
6. Metcalfe and Eddy Inc., Waste water Engineering: Treatment, Disposal and Reuse",4th Edition,McGraw Hill Book Co.,2003
7. Mackenzie L. Davis and David A. Cornwell, Introduction to Environmental Engineering,4th Edition,McGraw Hill Book Co.,2006.
8. Maier, R.M. Pepper I.L. and Gerba, C.P., Elsevier, Environmental Microbiology: A Laboratory Manual,2nd Edition,Academic Press,2004. 29
9. Bhattacharyya B.C. and Banerjee, R., Environmental Biotechnology, Oxford University Press 5. I. S. Thakur, Environmental Biotechnology: Basic concepts and Applications, I.K. International

Course Details			
Course Title: Metabolism and Metabolic Engineering			
Course Code	MSBTN1002E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To give students theoretical knowledge of different processes of life.
- To acquaint the students with bioenergetics, different metabolic pathways of carbohydrate, lipid, protein, nucleotide.
- To make the students understand different biochemical diseases with their reasons.
- The students will also learn the basics of metabolic engineering and its applications.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand various metabolic pathways and its regulations.
- Know about different diseases related to various biochemical pathways, their mechanism and think about their possible therapy as well.
- Think about different methods to manipulate various biochemical pathways and the basics of metabolic engineering.

Course Contents

Unit I: Carbohydrates (20% Weightage)

Digestion and absorption of carbohydrates, glycogenesis and glycogenolysis, glycogen storage diseases, interconversion of hexoses, glycolysis and gluconeogenesis. Cori's cycle, pyruvate dehydrogenase complex, kreb-cycle, glyoxalate pathway, pentosephosphate pathway and uronic acid pathway. Regulation of carbohydrate metabolism.

Unit II: Lipids (20% Weightage)

Digestion and absorption of fats. Oxidation of fatty acids-mitochondrial and peroxisomal Beta-oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Biosynthesis of fatty acids, desaturases. Phospholipids and glycosphingolipids-synthesis.

Unit III: Proteins (20% Weightage)

Digestion and absorption of proteins, general reactions of protein metabolism, essential amino acids. Metabolism of individual amino acids, One carbon metabolism, Inborn errors of protein metabolism. Enzymes in differential diagnosis of diseases and their clinical significance.

Unit IV: Nucleic acids (15% Weightage)

Biosynthesis and degradation of purines and pyrimidines and their regulation. Inherited disorders of purine and pyrimidine metabolism.

Unit V: Introduction to metabolic engineering (25% Weightage)

Concept and importance of metabolic engineering, improvement of microbial strain and fermentation processes by metabolic engineering, tools of metabolic engineering, Enhancement of productivity, extension of substrate range, extension of product spectrum and novel products, improvement of cellular properties, intervention in health and diseases, xenobiotics degradation.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
	Unit I: Carbohydrates
1	Digestion and absorption of carbohydrates
2-3	Glycogenesis and glycogenolysis, glycogen storage diseases
4	Interconversion of hexoses, glycolysis and gluconeogenesis
5	Cori's cycle
6	Pyruvate dehydrogenase complex
7	Kreb-cycle
8	Glyoxalate pathway, pentosephosphate pathway and uronic acid pathway
9	Regulation of carbohydrate metabolism
	Unit II: Lipids
10	Digestion and absorption of fats
11	Oxidation of fatty acids-mitochondrial and peroxisomal
12-13	Beta-oxidation, oxidation of unsaturated and odd chain fatty acids
14	Ketone bodies
15-16	Biosynthesis of fatty acids, desaturases
17-18	Phospholipids and glycosphingolipids-synthesis
	Unit III: Proteins
19	Digestion and absorption of proteins
20-21	General reactions of protein metabolism
22-23	Essential amino acids, Metabolism of individual amino acids
24	One carbon metabolism
25	Inborn errors of protein metabolism
26-27	Enzymes in differential diagnosis of diseases and their clinical significance
	Unit IV: Nucleic acids
28-31	Biosynthesis and degradation of purines and pyrimidines and their regulation
32-34	Inherited disorders of purine and pyrimidine metabolism
	Unit V: Introduction to metabolic engineering
35-37	Concept and importance of metabolic engineering
38-39	Improvement of microbial strain and fermentation processes by metabolic engineering
40-42	Tools of metabolic engineering
43	Enhancement of productivity, extension of substrate range,

	extension of product spectrum and novel products
44-45	Improvement of cellular properties, intervention in health and diseases, xenobiotics degradation
15 Hours	*Tutorials*

Suggested References:

1) Voet V and Voet J.G. Biochemistry.John Wiley Publishers.
2) Lehninger A.L. Principles of Biochemistry. W.H Freeman and Company.
3) Stryer L. Biochemistry. W.H. Freeman and Company.
4) Biochemistry of Rawn David J., Neil Patterson Publishers
5) Medical Biochemistry by N.V. Bhagavan, Harcourt Academic Press
6) Metabolic Engineering by S. Y. Lee and E. P. Popoutsakis (Eds), Marcel Dekker, New York, USA.
7) Metabolic Engineering by G. N. Stephanopoulous, A. A. Aristidon, J, Neilson, Academic Press, USA.
8) The Metabolic Pathway Engineering Handbook- Fundamenals Christina D Somlke

SECOND SEMESTER

Course Details			
Course Title: Cancer Biology			
Course Code	MSBTN2001E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To provide students with a conceptual understanding of the development of cancer at the cellular and molecular levels.
- To have a comprehensive idea on basic understanding of origin of cancer, signaling mechanisms, metabolic changes.
- To appreciate the complexity of cancer development.
- To emphasizes the relevant diagnostic and therapeutic approaches that are being used.

Learning Outcomes

After completion of the course the learners will be able to:

- Understand the cellular and molecular basis of cancer.
- Current strategies for cancer prevention and treatment.
- Take up the research in the frontier area of cancer biology.

Course Contents

UNIT I: Basics of Cancer: (25% Weightage)

Type of cancers, Cancer genomics, Causes of cancer, Risk factors, Cancer cell properties, In vitro and in vivo models of cancer research, Current methodology in cancer research.

UNIT II: Signaling Mechanisms in Cancer (25 % Weightage)

Oncogenes such as Ras, Src, etc., Tumor suppressor genes such as APC, p53 and Rb-E2F interaction, CDK-Cyclin-CDKI and CDC regulation in cancer progression, EGFR and IGFR signaling, Epigenetic mechanisms: DNA and histone modification, and micro RNA in Cancer, Mechanism of chemical, viral and radiation induced cancer.

UNIT III: Mitochondria and Cancer (30 % Weightage)

Warburg Hypothesis, Mitochondrial dysfunctions in cancer, mitochondrial genetics, metabolic alterations in cancer, oxidative stress, Apoptosis, Autophagy

UNIT IV: Cancer Diagnosis and therapeutic approaches (20% Weightage)

Cancer statistics, Cancer Screening Overview, Molecular diagnostics for detection of tumor, cancer specific markers, Types of Treatment, Side Effects, Clinical Trials, Cancer Drugs, Alternative Medicine.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
UNIT I: Basics of Cancer	
1-4	Type of cancers, Cancer genomics, Causes of cancer, Risk factors,
5-11	Cancer cell properties, In vitro and in vivo models of cancer research, Current methodology in cancer research.
UNIT II: Signaling Mechanisms in Cancer	
12-16	Oncogenes such as Ras, Src, etc., Tumor suppressor genes such as APC, p53 and Rb-E2F interaction, CDK-Cyclin-CDKI and CDC regulation in cancer progression, EGFR and IGFR signaling,
17-22	Epigenetic mechanisms: DNA and histone modification, and micro RNA in Cancer, Mechanism of chemical, viral and radiation induced cancer
UNIT III: Mitochondria and Cancer	
23-30	Warburg Hypothesis, Mitochondrial dysfunctions in cancer, mitochondrial genetics.
31-36	Metabolic alterations in cancer, oxidative stress, Apoptosis, Autophagy
UNIT IV: Cancer Diagnosis and therapeutic approaches	
37-40	Cancer statistics, Cancer Screening Overview, Molecular diagnostics for detection of tumor, cancer specific markers,
41-45	Types of Treatment, Side Effects, Clinical Trials, Cancer Drugs, Alternative Medicine.
15 Hours	*Tutorials*

Suggested References:

- Molecular Biology of Human Cancers by Wolfgang Arthur Schulz Springer.(2007).2nd edition
- Biology of Cancer by Robert Weinberg (2013). 2nd edition
- Chemoprevention of Cancer and DNA Damage by Dietary Factors by S. Knasmuller, David M. DeMarini, Ion Johnson, and Clarissa Gerhauser Willey- Blackwell Publisher. (2009). 1st edition
- Mitochondria Practical Protocols Editors: Leister, Dario, Herrmann, Johannes M. (Eds.) 2007 Publisher: Springer ISBN 978-1- 59745-365- 3
- Mitochondrial DNA: Methods and Protocols Editors: Stuart, Jeffrey A (Ed.) 2009 Springer Protocols Publisher: Springer ISBN 978-1- 59745-521- 3

Course Details			
Course Title: Intellectual Property Rights (IPR), Bioethics and Biosafety			
Course Code	MSBTN2002E04	**Credits**	4
L + T + P	3+ 1+ 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

Biotechnology and allied fields like Molecular Biology, Biochemistry and Microbiology are promising research-oriented and fast-growing interdisciplinary fields having applications in every sphere of life. Due to growing concerns arising from Genetically-Modified-Organisms (GMOs) it is necessary to understand various national and international biosafety guidelines and bioethics regulations to assess and control the related potential risks. This course consists of teachings like good laboratory procedure and practices, standard operating procedures for biotechnology research, legal and institutional framework for biosafety, international agreements and protocols for biosafety.

Learning Outcomes

The students will learn about the Intellectual property rights and their usages to protect work created by human mind that has commercial value. The course also makes students aware about different national and international IPR issues including patents, trademarks, copyrights etc. and various international agreements and treaties.

Course Contents

Unit I: Bioethics (33 % Weightage)

General ethics and ethical issues, Animal rights, Necessity of bioethics, different paradigms of bioethics- national and international, Ethical issues against molecular technologies, Regulations of Genetically Modified Organisms (GMOs), Environmental safety of GMOs, labelling of GM foods, Human Cloning, Bioethics for the future.

Unit II: Biosafety (33 % Weightage)

Definitions and biosafety levels, Biosafety for human and environment, General guidelines for rDNA research activity, Containment facilities and Biosafety practices, Guidelines for research in transgenic plants and applications, Structure and functions of Committees, DBT guidelines on biosafety in conducting research in biology/biotechnology.

Unit III: Intellectual property Right (34 % Weightage)

Basic Concepts of Intellectual Property: Introduction to intellectual property rights; Intellectual property laws; Trade Related Aspects of Intellectual Property Rights. Forms of IPR like Patent, design and copyright, trademark, IPR Laws.

Content Interaction Plan:

Lecture cum Discussion (Each session of 3 Hour)	**Unit/Topic/Sub-Topic**
Unit I: Bioethics	
1-3	General ethics and ethical issues,
4.6	Animal rights,
7-8	Necessity of bioethics,
9-11	Different paradigms of bioethics- national and international,
9-10	Ethical issues against molecular technologies,.
11-12	Regulations of Genetically Modified Organisms (GMOs),
13	Environmental safety of GMOs, labelling of GM foods,
14	Ethics in Human Cloning
15	Bioethics for the future
Unit II: Biosafety	
16-18	Definitions and biosafety levels
19	Biosafety for human and environment
20-21	General guidelines for rDNA research activity
22-23	Containment facilities and Biosafety practices
24-26	Guidelines for research in transgenic plants and applications
27-28	Structure and functions of Biosafety Committees
29-30	DBT guidelines on biosafety in conducting research in biology/biotechnology
Unit III: Intellectual Property Right	
31-34	Basic Concepts of Intellectual Property: Introduction to intellectual property rights
35-39	Intellectual property laws
40-43	Trade Related Aspects of Intellectual Property Rights
44-45	Forms of IPR like Patent, design and copyright trademark, IPR Laws
15 Hours	*Tutorials*

Suggested References:

1. Vaughn L. (2012) Bioethics: Principles, Issues, and Cases, 2nd Edition.Oxford University Press.
2. Singer P.A. and Viens A. M. (2008) The Cambridge Textbook of Bioethics, 1st Edition. Cambridge University Press.
3. Shannon T.A. and Kockler N.J.(2009) An Introduction to Bioethics, 4th Edition.Paulist Press.
4. Sateesh M. K. (2008) Bioethics And Biosafety. I.K. International Publication House Pvt Lts.
5. Joshi R. M. (2006) Biosafety and Bioethics.Isha Books, New Delhi
6. Gupta K., Karihaloo J. L. and Ketarpal R. K. (2008) Biosafety Regulations of Asia-Pacific Countries. Welay.
7. Richard W. S. (2001) Intellectual Property: Patents, Trademarks, and

Copyrights, 2nd Edition.West/Thomson Learning.

Course Details			
Course Title: Neuroscience			
Course Code	MSBTN2003E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Even	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To give students a basic understanding of how our nervous system is organized and how it functions.
- To acquaint the students with different sense organs and their functions.
- To promote students for integrative thinking about the brain, behaviour, learning & memory and how disorders of the brain impact us at different levels.
- To help students understand about different neurological disorders at different levels.

Learning Outcomes

After completion of the course the learners will be able to:

- Learn about anatomy and functioning of the central and peripheral nervous system.
- Gain knowledge about various type of cells found in the nervous system.
- Understand different types of learning and memory and senses.
- Think about therapies for various neurological disorders.

Course Contents

Unit I: Organization of the nervous system (25% Weightage)

Basics about the nervous system, Different types of the nervous system, Anatomy and functions of the Central Nervous System and Peripheral Nervous System, Different parts of the brain and their functions, Structure, functions and types of Neurons, Non-neuronal cells in the nervous system, Blood Brain Barrier.

Unit II: Neural signaling (10% Weightage)

Ion transport, Resting potential, Action potential, Synaptic transmission at excitatory and inhibitory synapses, Neurotransmitters.

Unit III: Sensory systems (15% Weightage)

Anatomy, biochemistry and functioning of Vision, Olfaction, Auditory and Motor system.

Unit IV: Brain and Behaviour (30% Weightage)

Chemical control of brain, Mental disorders like anxiety, mood disorders, depression, bipolar disorder, PTSD, Schizophrenia, Neurodegenerative diseases like Alzheimer's, Parkinson's, Huntington's, Multiple sclerosis, Amyelotrophic lateral sclerosis, Neurotechnology.

Unit V: Learning and Memory (20% Weightage)

Basics of learning and memory, Types of learning and memory, Long-term potentiation and depression, Different behavioural training paradigms, Associative and non-associative learning, reward and punishment learning, fear conditioning, Stages of memory, Sensory memory, short-term and long-term memory, Forgetting, Brain systems in memories.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	Unit/Topic/Sub-Topic
	Unit I: Organization of the nervous system
1-2	Basics about the nervous system
3	Different types of the nervous system
4-5	Anatomy and functions of the Central Nervous System and Peripheral Nervous System
6-8	Different parts of the brain and their functions
9-10	Structure, functions and types of Neurons
11	Non-neuronal cells in the nervous system
12	Blood Brain Barrier
	Unit II: Neural signalling
13	Ion transport
14	Resting potential, Action potential
15	Synaptic transmission at excitatory and inhibitory synapses
16-18	Neurotransmitters
	Unit III: Sensory systems
19-20	Anatomy, biochemistry and functioning of Vision
21-22	Olfaction
23	Auditory
24	Motor system
	Unit IV: Brain and Behaviour
25	Chemical control of brain
26-27	Mental disorders like anxiety, mood disorders
28	depression, bipolar disorder
29-30	PTSD, Schizophrenia
31-32	Neurodegenerative diseases like Alzheimer's
33-34	Parkinson's
35	Huntington's
36	Multiple sclerosis
37	Amyelotrophic lateral sclerosis
38	Neurotechnology
	Unit V: Learning and Memory
39	Basics of learning and memory, Types of learning and memory
40	Long-term potentiation and depression

41	Different behavioural training paradigms
42-43	Associative and non-associative learning, reward and punishment learning, fear conditioning
44	Stages of memory, Sensory memory, short-term and long-term memory
45	Forgetting, Brain systems in memories
15 Hours	*Tutorials*

Suggested References:

1) Kandel E. R. (2012) Principles of Neural Science, Fifth Edition.
2) Purves D., Augustine G. J. and Hall W. C. (2011) Neuroscience, Fifth Edition.
3) Nicholls J. G. and Martin A. R (2011) From Neuron to Brain, Fifth Edition.

THIRD SEMESTER

Course Details			
Course Title: Neurological Diseases and Techniques			
Course Code	MSBTN3001E04	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 15 (T) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To make students understand the basics of our nervous system.
- To give them knowledge on the pathophysiology of neurodegenerative diseases.
- The students will learn genetics of neurodegeneration, pathomechanisms of disease development, and current research models of disease.

Learning Outcomes

After completion of the course the learners will be able to:

- Describe the basic anatomy and physiology of the brain and nerves.
- Learn about neurological mechanisms underlying behind ageing.
- Understand the symptoms of most common neurodegenerative diseases, genetics of neurodegeneration, pathomechanisms of disease development and different treatment options.

Course Contents

Unit I: Organization of the nervous system (30% Weightage)

Basics about the nervous system, Different types of the nervous system, Anatomy and functions of the Central Nervous System and Peripheral Nervous System, Different parts of the brain and their functions, Structure, functions and types of Neurons, Non-neuronal cells.

Unit II: Neurobiology of aging (15% Weightage)

Theories of aging, Neurobiology of aging, cellular and molecular aspects of neuronal aging, Aging and neurodegeneration

Unit III: Mood disorders (15% Weightage)

Biochemical aspects of the psychotic disorders, Biochemical basis of mental illness: Anxiety disorders; Attention disorders; Schizophrenia.

Unit IV: Neurodegenerative diseases (20% Weightage)

Prion's Disease, Neurochemical and molecular mechanisms of peripheral Neuropathy; Diseases involving myelin; Multiple sclerosis and other demyelinated disorders, Parkinson's disease, Genetics and diagnosis of Huntington disease and other triplet repeat disorders; Alzheimer's disease: Molecular, genetic, immunological aspects and diagnostics.

Unit V: Neurological Techniques (20% Weightage)

Electroencephalography (EEG), Magnetoencephalography (MEG), Functional magnetic resonance imaging (fMRI), Positron emission tomography (PET), Computed Axial Tomography (CAT), Event-related optical signal (EROS), Transcranial magnetic stimulation (TMS)

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
	Unit I: Organization of the nervous system
1-2	Basics about the nervous system, Different types of the nervous system
3-6	Anatomy and functions of the Central Nervous System and Peripheral Nervous System
7-10	Different parts of the brain and their functions
11-13	Structure, functions and types of Neurons
14-15	Non-neuronal cells
	Unit II: Neurobiology of aging
16-17	Theories of aging, Neurobiology of aging
18-19	Cellular and molecular aspects of neuronal aging
20-21	Aging and neurodegeneration
	Unit III: Mood disorders
22	Biochemical aspects of the psychotic disorders
23-24	Biochemical basis of mental illness: Anxiety disorders
25-26	Attention disorders
27	Schizophrenia
	Unit IV: Neurodegenerative diseases
28	Prion's Disease

29	Neurochemical and molecular mechanisms of peripheral Neuropathy
30	Diseases involving myelin
31-32	Multiple sclerosis and other demyelinated disorders
33-34	Parkinson's disease
35	Genetics and diagnosis of Huntington disease and other triplet repeat disorders
36-37	Alzheimer's disease: Molecular, genetic, immunological aspects and diagnostics.
	Unit V: Neurological Techniques
38	Electroencephalography (EEG)
39	Magnetoencephalography (MEG)
40-41	Functional magnetic resonance imaging (fMRI)
42	Positron emission tomography (PET)
43	Computed Axial Tomography (CAT)
44	Event-related optical signal (EROS)
45	Transcranial magnetic stimulation (TMS)
15 Hours	*Tutorials*

Suggested References:

1) Eric R. Kandel, James H. Schwartz, Thomas M. Jessell (2000) Principles of Neural Science, Fourth Edition (McGraw-Hill Companies,Incorporated).
2) Hadi Manji with Sean Conolly, Neil Dorward, Neil Kitcheen, Amrish Mehta, Adriam Wills (2007) Oxford Handbook of Neurology (Oxford University Press)
3) Relevant scientific articles and reviews.

Course Details			
Course Title: Techniques in Molecular Diagnostics and Stem Cell Technology			
Course Code	MSBTN3002E04	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	45 (L) + 30 (P) Hours
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To provide a comprehensive understanding of the basic principles of the rapidly growing field of molecular diagnostics applicable to clinical laboratories, research, food, dairy and pharma industries.
- With an overview of essentials the course addresses various molecular biology methods related to DNA, RNA and proteins.

- It will provide an experience and preliminary training in the essential and reasonably common tools/techniques that are used to isolate, culture, and expand stem cells, manipulate/engineer stem cells, characterize differentiation, and control microenvironments for elucidation of mechanisms and translation for specific applications.
- Hands on experiments for some of the most commonly used techniques have also been included to develop skills relevant to molecular diagnostic laboratory for future entrepreneurships and start-ups.

Learning Outcomes

- Knowledge and understanding of the basic principle used molecular diagnostics
- Gain thinking and analysis skills to understand new diagnostic methods.
- Ability to collect new information to design new diagnostic kits.
- Gain knowledge for important parameters in the design of a laboratory to conduct the most commonly used molecular diagnostic procedures.
- Gain knowledge to identify the important parameters in the design of a quality system for molecular analyses.
- Become proficient with the techniques required to perform the most commonly used molecular diagnostics protocols.
- Identify the components of a well-controlled diagnostic test.
- Gain knowledge for critical thinking skills to trouble shoot problems as they occur and determine possible causes.
- How stem cells are currently being used in the clinic and what kinds of future treatments lie on the horizon.

Course Contents

UNIT I: DNA and RNA based Molecular Diagnosis (20% Weightage)

Principles and techniques; Nucleic acid isolation and quantitation methods, Primer designing, Types of PCR. DNA & RNA hybridization techniques, in-situ (FISH), microarrays, Detection of microbial pathogens through PCR. RAPD for animal and plants. Application in forensics, paternity identification, sex determination and detecting genetic disorders.

UNIT II: Clinical Proteomics (20 % Weightage)

Overview of immune system, Immunotherapy and immunodiagnostics, antigen-antibody binding interactions and assays; antibodies, Immunoassays – types and specific applications; Immunohistochemistry – principle and techniques. Application in diseases.

UNIT III: Stem cell culture (40 % Weightage)

Principles and Techniques of stem cell culture. Media and reagents used for stem cell culture, Different tissue culture techniques for propagation and maintenance of stem cells, Trypsinization, Cell separation, Cryopreservation, Common cell culture contaminants. Stem cell classification and location, Germ line Epithelial and Epidermal and neural niches, Muscle and Cardiac Stem Cells. Differentiation status of cells, primordial germ cell, Skin cell, gastrointestinal cells. Embryonic stem cell differentiation as a model to study haematopoietic and endothelial cell development. Cancer Stem Cells.

UNIT IV: Application of stem cell technologies (20% Weightage)

Reprogramming, Nuclear Transfer, Transcription factors, trans-differentiation, Cloning, Chromatin structure & Epigenetics, Single-Cell PCR methods for studying stem cells. Animal Models of Regeneration, Uses of Stem cells - Human stem cells, Stem cells and Tissue engineering, Embryonic stem cells and Gene therapy, IVF Techniques, Therapeutic cloning.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
UNIT I: DNA and RNA based Molecular Diagnosis	
1-4	Principles and techniques; Nucleic acid isolation and quantitation methods, Primer designing, Types of PCR. DNA & RNA hybridization techniques, in-situ (FISH), microarrays.
5-9	Detection of microbial pathogens through PCR. RAPD for animal and plants. Application in forensics, paternity identification, sex determination and detecting genetic disorders.
UNIT II: Clinical Proteomics	
10-12	Overview of immune system, Immunotherapy and immunodiagnostics,
13-18	Antigen-antibody binding interactions and assays; antibodies, Immunoassays – types and specific applications; Immunohistochemistry – principle and techniques. Application in diseases.
UNIT III: Stem cell culture	
19-24	Principles and Techniques of stem cell culture. Media and reagents used for stem cell culture, Different tissue culture techniques for propagation and maintenance of stem cells, Trypsinization, Cell separation, Cryopreservation, Common cell culture contaminants.
25-32	Stem cell classification and location, Germ line Epithelial and Epidermal and neural niches, Muscle and Cardiac Stem Cells. Differentiation status of cells, primordial germ cell, Skin cell, gastrointestinal cells
32-36	Embryonic stem cell differentiation as a model to study haematopoietic and endothelial cell development. Cancer Stem Cells.
UNIT IV: Application of stem cell technologies	
37-39	**Unit-IV:** Reprogramming, Nuclear Transfer, Transcription factors, trans-differentiation, Cloning,
40-42	Chromatin structure & Epigenetics, Single-Cell PCR methods for studying stem cells. Animal Models of Regeneration, Uses of Stem cells.
43-45	Human stem cells, Stem cells and Tissue engineering, Embryonic stem cells and Gene therapy, IVF Techniques, Therapeutic cloning.
30 Hours	*Practicals* ***DNA & RNA Methods: (9 hrs)*** • *Isolation of DNA/RNA from microbe (E.coli), Plant, mammalian cell lines and Human (Peripheral Blood).*

	• *Plasmid DNA isolation by Alkaline lysis and Boiling method.* • *Quality / Quantity checking of Nucleic acids by a) UV Spectrophotometer and b) Agarose Gel Electrophoresis.* • *Restriction digestion* • *Polymerase Chain Reaction (PCR)* ***Protein methods (6 hrs)*** • *Protein isolation, quantitation, and resolution by SDS-PAGE* • *Western blotting & ELISA* ***Immunological methods(6hrs)*** • *Blood typing (ABO determination)* • *Precipitation, Immunodiffusion, Immunoelectrophoresis* ***Animal/stem cell culture experiments: (9 hrs)*** • *Isolation of stem cells and maintenance of animal/stem cells, Trypsinization, sub-culturing and cryopreservation* • *Viability analysis.*

- Suggested References:
- An Introduction to Genetic Analysis (2000) by A.J.F. Griffiths, J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart, W.H. Freeman, New York.
- Essentials of Molecular Biology (1998) by G. M. Malacinski and D. Friefelder, Jones & Bartlett Publishers.
- Genomics and Clinical Medicine; Dhavendra Kumar and David Weatherall; Oxford University Press 2008 ISBN 13: 978019518834
- Molecular Testing in Laboratory Medicine: Selections from Clinical Chemistry, 1998-2001; David E. Bruns, Y.M. Dennis Lo, and Carl T. Wittwer; AACC Press 2003 ISBN: 1890883603 $62.00 ($50.00 for AACC members).
- Kuby Immunology, 7th Edition by Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby (2013)
- Principles and Practice of Immunoassay, 2nd Sub Edition by Christopher P. Price and David J. Newman (1997)
- Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2010
- Essentials of Stem Cell Biology, Second Edition Robert Lanza, John Gearhart. Academic Press
- Gilbert, S.F. 2006. Developmental Biology. Sinauer Associates
- Turksen, K. 2004. Adult Stem Cells. Humana Press, Inc.
- Thomson, J et al. 2004. Handbook of Stem Cells: Embryonic/ Adult and Fetal Stem cells (Vol. 1 & 2). Academic Press.

ASSESSMENT AND EVALUATION IN BIOTECHNOLOGY FOR SKILL BASED COURSES (10/5/2019)

Course Details			
Course Title: *Drosophila* Techniques			
Course Code	MSBTN3001S00	**Credits**	0
L + T + P	0 + 0 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To make the students familiar with the *Drosophila* model system, its importance and significance.
- To train the students for working with *Drosophila* (fruit flies), identification of sexes, their life cycle.
- To train the students for using different behavioural paradigms to measure olfactory learning and memory, basic genetics and molecular biology using flies.

Learning Outcomes

After completion of the course the learners will be able to:

- Learn about the fly model system, how to work with this to solve different biological problems.
- Plan and do research on various neurological problems using fly model.
- Develop a fly lab themselves.

Course Contents

Unit I: Culturing the flies (20% Weightage)

Different types of culturing media used for rearing flies, learning techniques to keep the flies healthy

Unit II: Life cycle of flies (15% Weightage)

Gain an understanding of the life cycle of *D. melanogaster*, an insect which exhibits complete metamorphosis

Unit III: Setting up genetic crosses (20% Weightage)

Identification of male and female flies, virgin flies, collection of virgin flies and setting up genetic crosses and observe the effects in the next generation.

Unit IV: Behavioural experiments (25% Weightage)

Measuring olfaction, learning and memory in larvae and adult of flies.

Unit V: Molecular Biology with flies **(20% Weightage)**

Extraction of genomic DNA, RNA and protein from flies.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
	Unit I: Culturing the flies
1-2	Different types of culturing media used for rearing flies.
3	Learning techniques to keep the flies healthy.
	Unit II: Life cycle of flies
4-5	Gain an understanding of the life cycle of *D. melanogaster*, an insect which exhibits complete metamorphosis.
	Unit III: Setting up genetic crosses
6	Identification of male and female flies, virgin flies.
7-8	Collection of virgin flies and setting up genetic crosses and observe the effects in the next generation.
	Unit IV: Behavioural experiments
9-10	Measuring olfaction.
11-12	Learning and memory in larvae and adult of flies.
	Unit V: Molecular Biology with flies
13	Extraction of genomic DNA from flies.
14	Extraction of RNA from flies
15	Extraction of Protein from flies

Suggested References:

1) *Drosophila*: Methods and Protocols, Editors: Dahmann, Christian (Ed.), Springer
2) *Drosophila* Protocols: By William Sullivan, University of California, Santa Cruz; Michael Ashburner, University of Cambridge; R. Scott Hawley
3) Fly Pushing: The Theory and Practice of Drosophila Genetics: The Theory and Practice of Drosophila Genetics by Ralph J. Greenspan, Cold Spring Harbor Laboratory Press

Content Interaction Plan:

Practical cum Discussion (Each session of 3 Hours)	**Unit/Topic/Sub-Topic**
	Unit I: Culturing the flies
1-6	Experiment 1: Preparation of corn meal agar media for culturing flies, transfer of flies
	Unit II: Life cycle of flies
7-12	Experiment 2: Identification of different stages of flies in their life cycle.
	Unit III: Setting up genetic crosses

13-18	Experiment 3: Identification of male and female flies, Collection of virgin female flies and setting up genetic crosses with males.
	Unit IV: Behavioural experiments
19-21	Experiment 4: Setting up two-choice assay for measuring olfaction in adult flies.
22-24	Experiment 5: Training and measuring learning and memory in larvae and adults of flies.
	Unit V: Molecular Biology with flies
25-30	Experiment 6: Extraction of genomic DNA, RNA and protein from flies.

Suggested References:

1. Drosophila: Methods and Protocols, Editors: Dahmann, Christian (Ed.), Springer

2. Drosophila Protocols: By William Sullivan, University of California, Santa Cruz; Michael Ashburner, University of Cambridge; R. Scott Hawley

Course Details			
Course Title: *Village Based Skills*			
Course Code	MSBTN3002S00	**Credits**	0
L + T + P	0 + 0 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	
Methods of Content Interaction	Group discussion; Visiting nearby village to learn skills.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

For MSBTN4002S00 (Village based skills), the Department should contact Mukhiya and Sarpanch of that particular village for their visit. Financial support for MSBTN4002S00 should be provided by the University. After the visit student should submit the report.

Course Objectives

- To make the students familiar with the skills such as pottery making, natural fiber roof etc. prevalent in villages.
- To show the students the way villagers lead their life.

Learning Outcomes

After completion of the course the learners will be able to:

- Learn about several small level skill developments.
- They will understand about the ways the villagers adopt for their healthy and good life.

Course Details			
Course Title: ***Field and Excursion Tour***			
Course Code	MSBTN3003S00	**Credits**	0
L + T + P	0 + 0 + 0	**Course Duration**	One Semester
Semester	Odd	**Contact Hours**	
Methods of Content Interaction	Visiting Biotechnology Based Industries		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

For MSBTN4003S00 (Village based skills), the Department should ask for Financial support and it should be provided by the University for successful completion of this course. After the visit student should submit the report.

Course Objectives

- To make the students familiar with the Biotechnology Based Industries involved in the production of drugs.
- To show the students the process of fermentation.
- To show the students R &D related to stem cell research and other high end research.

Learning Outcomes

After completion of the course the learners will be able to:

- Learn about optimization process involved in the industries.
- They will understand about the ways for scaling up the production of the products from lab to industry.

Swayam/Self Study Based Courses

We have also identified Swayam based courses. As all the four identified courses are non-credit so we have allotted the credit which will be approved by BoS for its implementation and also student has option to enroll in any courses which are being offered in that semester.

Course Code	**Courses**	**Non -Credits**		
		L	**T**	**P**
MSBTN1001S02	Introductory Mathematical Methods for Biologists			
MSBTN2001S02	Bio-energetics of Life Processes			
MSBTN3001S02	Principles of Downstream Techniques in Bioprocess			
MSBTN4004S02	Human Molecular Genetics			

Note - Swayam based courses are updated regularly and students can opt any other updated courses even if it is not mentioned in the list given above.