B. Sc. Biotechnology

Name of Program	**M. Sc. Integrated Biotechnology**
Abbreviation	**BT**
Duration	**3 Years**
Medium of Instruction	English
Program Structure	Semester I

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	4	4	4	2 +2 Hrs	50	20	70
	Core 2	4	4	4	2 +2 Hrs	50	20	70
	Core 3	4	4	4	2 +2 Hrs	50	20	70
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	BTP - 01	0	4	2	4 Hrs	40	40	80
	MBP - 103	0	4	2	4 Hrs	40	40	80
	Z 101/102 / BOT 103	0	4	2	4 Hrs	40	40	80
	Total	18	12	24	30Hrs	420	220	660

Program Structure	Semester II

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	4	4	4	2 +2 Hrs	50	20	70
	Core 2	4	4	4	2 +2 Hrs	50	20	70

	Core 3	4	4	4	2 +2 Hrs	50	20	70
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	BTP - 02	0	4	2	4 Hrs	40	40	80
	MBP - 203	0	4	2	4 Hrs	40	40	80
	Z 201/202 / BOT 203	0	4	2	4 Hrs	40	40	80
	Total	18	12	24	30Hrs	420	220	660

Course Code	**BT-01**
Course Title	**INTRODUCTION TO BIOTECHNOLOGY**
Credit	4
Teaching per Week	4
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	To provide knowledge to students regarding fundamental concepts of Biotechnology.
Course Objective	To help them gain knowledge regarding scope of Biotechnology and to discuss the application part of Biotechnology.
Course Outcomes	CO1: To explain students about the fundamentals of Biotechnology, to explain them the interdisciplinary pursuit of biotechnology, to make them aware about public perception of biotechnology. CO2: To make them aware about the scope of biotechnology in form of different fields and concepts used in biotechnology. CO3: Students will be given idea for use of biotechnology concept in environmental, animal, plant, microbiology, health and diagnostics related studies. CO4: To provide them information related to biotechnology-based institutes and organizations in India, to explain them biotechnological application in industries.
Mapping between COs with PSOs	
Pre-requisite	Basic science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	**UNIT-1: UNDERSTANDING BIOTECHNOLOGY:** 1.1 What is Biotechnology? 1.2 Biotechnology-an interdisciplinary pursuit 1.3 Biotechnology- a three-component central core 1.4 Product safety 1.5 Public perception of Biotechnology 1.6 Biotechnology and developing world **UNIT-2: SCOPE OF BIOTECHNOLOGY-I:** 2.1 Recombinant DNA and genetic engineering 2.2 Mammalian cell culture 2.3 Plants and plant cell culture 2.4 Bio-fuels 2.5 Bio-catalysis 2.6 Waste Water and Sewage treatment **UNIT-3: SCOPE OF BIOTECHNOLOGY-II:** 3.1 Fermentation 3.2 Bio-fertilizer 3.3 Bio-pesticides 3.4 Vaccines 3.5 Monoclonal antibodies 3.6 Diagnostics in developing countries **UNIT-4: BIOTECHNOLOGY IN INDIA:** 4.1 Introduction to DBT 4.2 Autonomous institutions of DBT 4.3 Public sector undertakings of DBT 4.4 BTIS-NET 4.5 Introduction to ABLE 4.6 Biotechnology- Current status of industrial growth in India
Reference Books	**REFERENCES:** 1. Karp, G. (2014) *Cell Biology*, 7th Edition, International Student Version, Wiley. 2. Willey, J. M., Sherwood, L. M. & Woolverton, C. J. (2017) *Prescott, Harley & Klein's Microbiology*, 10th Edition, The McGraw-Hill Companies, Inc.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BT-02**
Course Title	**CELL BIOLOGY**
Credit	4
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019

<table>
<tr><td>Purpose of Course</td><td>The purpose of the course is to provide insights about basics of cell biology including cell membrane and cell cycle</td></tr>
<tr><td>Course Objective</td><td>To acquaint students with the concepts of cell biology</td></tr>
<tr><td>Course Outcomes</td><td>CO1: To acquaint students with basic properties of cell, cell theory and fundamental classes of cell.

CO2: To elaborate on brief history of plasma membrane, structure, composition, and functions of plasma membrane.

CO3: Students will acquire concepts of dynamic nature of plasma membrane, types of movement across plasma membrane and membrane potential.

CO4: Students will gain fundamentals of cell cycle stages and control.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic science</td></tr>
<tr><td>Course Content</td><td>UNIT-1: FUNDAMENTALS OF CELL:
1.1 Discovery of cells
1.2 Basic properties of cells
1.3 Fundamental classes of cells: (Ultra structure and functions)
1.3.1 Prokaryotic cell
1.3.2 Eukaryotic cells (Plant and Animal)
1.4 Viruses

UNIT-2: CELLULAR MEMBRANES: STRUCTURE
2.1 Brief history of studies on plasma membrane structure
2.2 Chemical composition of membranes
2.3 Structure and functions of membrane proteins
2.4 Membrane lipids & membrane fluidity

UNIT-3: CELLULAR MEMBRANES: FUNCTIONS
3.1 An overview of membrane functions
3.2 Dynamic nature of plasma membrane
3.3 Movement of substances across cell membrane
3.4 Membrane potentials & nerve impulses

UNIT-4: CELL CYCLE, MITOSIS AND MEIOSIS:
4.1 The Cell Cycle:
4.1.1 Cell cycle in vivo
4.1.2 Control of cell cycle
4.2 M Phase: Mitosis & Cytokinesis:
4.2.1 Prophase
4.2.2 Pro-metaphase
4.2.3 Metaphase
4.2.4 Anaphase
4.2.5 Telophase
4.2.6 Forces required for mitotic movements</td></tr>
</table>

	4.2.7 Cytokinesis 4.3 **Meiosis:** 4.3.1 The stages of meiosis 4.3.2 Genetic recombination during meiosis
Reference Books	**REFERENCES:** 1. Karp, G. (2014) *Cell Biology*, 7th Edition, International Student Version, Wiley. 2. Willey, J. M., Sherwood, L. M. & Woolverton, C. J. (2017) *Prescott, Harley & Klein's Microbiology*, 10th Edition, The McGraw-Hill Companies, Inc.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BTP-01**
Course Title	**Biotechnology Practical**
Credit	2
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to gives basic knowledge about the laboratory work and instrumentation.
Course Objective	To provide education that leads to comprehensive understanding of the principles and practices of biotechnology.
Course Outcomes	CO1: Students have a knowledge of all laboratory instruments and its principle and use. CO2: Students have a knowledge of General laboratory safety rules and methods. CO3: Train students have an idea regarding disposal of laboratory waste and infected cultures. CO4: Explain and train students have subjective knowledge of Bioprocess, Animal Cell Culture and Plant Tissue Culture laboratories.
Mapping between COs with PSOs	
Pre-requisite	Basic science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	1. Principle, working and uses of laboratory instruments: [Microscope, Incubator, pH meter, Centrifuge, Colony counter] 2. Principle, working and uses of various types of sterilizers: [Hot air oven, Steam sterilizer, Inspissator, Bacteriological filters] 3. Introduction to Bioprocess, Animal Cell Culture and Plant Tissue Culture laboratories 4. General laboratory safety and instructions 5. Preparation and sterilization of glassware's and media, disposals of media and cultures 6. DNA staining by Schiff's reagent using onion peel 7. Study of various stages of meiosis using permanent slides 8. Study of various stages of mitotic cell division using onion root tips 9. Barr body from buccal smear 10. Geimsa staining of Blood cells
Reference Books	1. Patel RJ, Patel KR. Experimental microbiology Part II. Aditya Publication, Ahmedabad. 2016. 2. K.R .Aneja Experimental in Microbiology plant Pathology and Biotechnology.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Semester 2 BT

Course Code	BT-03
Course Title	Basic Biochemistry
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to make the student capable of understanding the basic biochemical process of evolution. It makes the student to understand various energy transfer process, and also makes students able to understand basic biochemistry of water and importance of buffers and their preparation.
Course Objective	The main objective of course is to give basic understanding about the chemistry of living cell.
Course Outcomes	CO1 : explain students about basic knowledge about biochemistry CO2 : explain about relationship between mutation and evolution CO3 : give insight in to various energy transfer processes with cell economy CO4 : knowledge about different types of buffers and their preparation with its significance
Mapping between COs with PSOs	

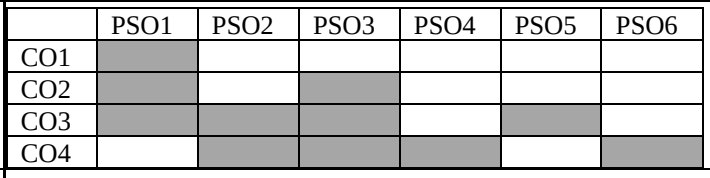
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Pre-requisite	Basic Science
Course Content	**UNIT-1: EVOLUTIONARY FOUNDATIONS:** 1.1 Changes in the hereditary instructions 1.2 Appearance of bio-molecules 1.3 A possible "RNA world" scenario 1.4 Biological evolution 1.5 Synthetic cells 1.6 Evolution of eukaryotic cells 1.7 Functional genomics and its importance in human biology & medicine **UNIT-2: PHYSICAL FOUNDATIONS:** 2.1 Dynamic steady state of living organisms 2.2 Energy transformation in living organisms 2.3 Flow of electrons as source of energy 2.4 Requirement of work and energy for creation and maintenance 2.5 Energy coupling links reactions in biology 2.6 Enzymes promote sequences of chemical reactions 2.7 Regulation to achieve balance and economy **UNIT-3: WATER:** 3.1 Non-covalent interactions among bio-molecules in aqueous solvent 3.1.1 Hydrogen bonds 3.1.2 Ionic interactions 3.1.3 Hydrophobic interactions 3.1.4 Van der Waals interactions 3.2 Water as a reactant 3.3 Fitness of the aqueous environment for living organisms **UNIT-4: BUFFERS & pH:** 4.1 Ionization of water, weak acids and weak bases 4.2 pH scale 4.3 Types of buffers
Reference Books	1. Cox, M. M., & Nelson, D. L., (2017). *Lehninger: Principles of Biochemistry*, 7th Edition, W. H. Freeman, New York. 2. Powar, C. B., & Chatwal, G. R., (2011). *Biochemistry*, Himalaya Publishing House, India.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BT-04
Course Title	Fundamentals of Genetics
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020

<table>
<tr><td>Purpose of Course</td><td>The purpose of this course is to be provide insights of fundamentals related to genetics which is one of the important subject of biotechnology course.</td></tr>
<tr><td>Course Objective</td><td>To provide basic laws of inheritance which are the keys to understand human genetics</td></tr>
<tr><td>Course Outcomes</td><td>CO1: This unit deals with basic concept of genome and its organization. This unit is foundation of the genetics course and expected outcome is to know how this science came into existence with the contribution of several scientist
CO2: Second unit is Chromosomes & Nucleosomes. Students get insight to finer details of genetic material. Expected outcome is to understand how different regions of chromosome responsible for inheritance
CO3: Third unit is related to Large scale chromosomal changes. In this unit students would be imparted with aspects related to structure and number of chromosomes.
CO4: Fourth unit is about Patterns of inheritance in humans. Expected outcome of this unit would be information about the cause of several genetic disorders which are prevalent among humans. Importance of genetic counselling would be understood for prevention of them in society.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1: CONCEPT OF GENOME AND ITS ORGANIZATION:
1.1 Mendel’s discoveries
1.2 History of genetics
1.3 DNA as genetic material
1.3.1 Griffith’s Transformation Experiment
1.3.2 Avery’s experiment
1.3.3 Hershey-Chase Experiment
UNIT-2: CHROMOSOMES & NUCLEOSOMES:
2.1 Euchromatin and Heterochromatin
2.2 Nucleosome-subunit of all chromatin
2.3 Banding Patterns in chromosomes
2.4 Lampbrush & Polytene chromosomes
UNIT-3: LARGE-SCALE CHROMOSOMAL CHANGES:
3.1 Euploids & Aneuploids
3.2 The concept of gene balance
3.3 Deletions & Duplications
3.4 Reciprocal & Robertsonian translocations
UNIT-4: PATTERNS OF INHERITANCE IN HUMANS:
4.1 Pedigree analysis of autosomal recessive disorders
4.2 Pedigree analysis of autosomal dominant disorders
4.3 Pedigree analysis of X-linked dominant and recessive disorders
4.4 Y-linked inheritance
4.5 The Hardy-Weinberg Law</td></tr>
<tr><td>Reference Books</td><td>1. Griffiths, A. F., Wessler, S. R., Lewontin, R. C. and Carroll, S. B. (2008) Introduction to Genetic Analysis, 9th Edition, W. H. Freeman and Company, New York.
2. Klug, W. S. and Cummings, M. R. (2007) Concepts of Genetics, 7th Edition, Pearson Education.</td></tr>
</table>

Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**Practical Core 1: BTP-02:**
Course Title	Biotechnology practical
Credit	2
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	To provide hand's on experience of using instruments in the laboratory for biotechnology purpose.
Course Objective	Biotechnology is practical based course so main objective of this course is to acquaint students about how to make different solutions, buffers and solve problems based on Mendelian genetics
Course Outcomes	CO1: To learn how to prepare different solutions of different concentrations. CO2: To learn how to prepare stock and working solutions. CO3: To learn how to prepare different buffers used in biotechnology practical's. CO4: To learn how determine the Acid value. Outcome would be to know the importance of fats and oils by their acid values. CO5: To learn how to use pH meter and calibrate it. CO6: This group of practical's is based on course Fundamentals of Genetics. Outcome of those would be to know the contribution of various scientists in this field as well as to solve problems related to Mendelian genetics.
Mapping between COs with PSOs	
Pre-requisite	Basic science
Course Content	1. Preparation of normal, molar and molal solutions 2. Preparation of stock and working solutions 3. Preparation of buffer (Phosphate, Glycine-NaOH, Glycine-HCl) 4. Determination of acid value of fats and oils by titration with KOH 5. Calibration of pH meter 6. Identification of eye colour in Drosophila 7. Contribution of scientists in the field of genetics 8. Study of permanent slides/photographs of banding techniques 9. Problems related to Mendelian genetics

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

	10. Pedigree analysis of human genetic disorders
Reference Books	1. Patel RJ, Patel KR. Experimental microbiology Part II. Aditya Publication, Ahmedabad. 2016. 2. K.R .Aneja Experimental in Microbiology plant Pathology and Biotechnology. 3. Abhijit Dutta Experimental Biology A laboratory manual.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

M. Sc. Integrated Biotechnology III and IV

Name of Program	**M. Sc. Integrated Biotechnology**
Abbreviation	**BT**
Duration	**3 Years**
Program Structure	Semester III

Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal Marks**	**Total Marks**
		Theory	**Practical**		**Duration**	**Marks**		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	6	6	6	2 +2Hrs	50	20	70
	Core 2	6	6	6	2+2 Hrs	50	20	70
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	BTP 06	0	6	3	2 x 4 Hrs	60	60	120
	MBP 304	0	6	3	2 x 4 Hrs	60	60	120
	Total	18	24	24	30 Hrs	370	220	590

Program Structure	Semester IV

Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal Marks**	**Total Marks**
		Theory	**Practical**		**Duration**	**Marks**		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	6	6	6	2 +2Hrs	50	20	70
	Core 2	6	6	6	2+2 Hrs	50	20	70
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	BTP 04	0	6	3	2 x 4 Hrs	60	60	120
	MBP 404	0	6	3	2 x 4 Hrs	60	60	120
	Total	18	24	24	30 Hrs	370	220	590

B.Sc. 3rd Semester

Course: 05: Instrumentation and Techniques

Course Code	**BT-05**
Course Title	**Instrumentation and Techniques**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The purpose of this course is to acquaint students about the principle and working of preliminary instruments used in biotechnology practical's.
Course Objective	To provide basic knowledge of various techniques and instrumentation utilized in biotechnology course
Course Outcomes	CO1: This unit deals with Potentiometry. Here concept of pH and instrumentation details of pH meter is to be explained. Students would learn how to use, calibrate and take care of instrument. CO2: Second unit is Separation & Measurement Techniques. Important details about various separation techniques in chromatography as well as use of radioactivity in detection of biomolecules are discussed. CO3: Third unit is about Centrifugation Principles of centrifugation help students to use proper centrifuge and rotor specific to the work needed. Also how to maintain and take care of safety aspects while using the instrument in the laboratory. CO4: Fourth unit is about Spectrophotometry. Students were explained about the law's of photometry and different types of spectrophotometers. After learning these concepts students would able to perform the experiments with better understanding
Mapping between COs with PSOs	
Pre-requisite	12th Science with Biology Subject
Course Content	**UNIT-1: POTENTIOMETRY** 1.1 pH Electrode: Reference electrode, Glass electrode, Combine electrode 1.2 Construction, operation and use of pH meter 1.3 Maintenance of electrodes 1.4 Ion selective meter and electrode for Ca+2, F-, Biomembrane electrode **UNIT-2: SEPARATION & MEASUREMENT TECHNIQUES** 2.1 Classification of chromatography & general principles 2.2 Principles of Paper chromatography and Thin Layer Chromatography 2.3 Development methods 2.4 Detection, measurement and use of radioactivity in Biology: 2.4.1 Geiger-Muller counter: working principle and application 2.4.2 Scintillation counter: working principle and application

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

	2.4.3 Autoradiography: Techniques and applications **UNIT-3: CENTRIFUGATION** 3.1 Basic principles of sedimentation, Types of centrifuges and rotors 3.2 Separation methods in preparative ultracentrifuges: 3.2.1 Differential centrifugation 3.2.2 Density gradient centrifugation 3.2.3 Analysis of sub cellular fractions 3.3 Application of analytical ultracentrifuge: 3.3.1 Determination of relative molecular mass 3.3.2 Estimation of purity of macromolecules 3.3.3 Conformational changes in macromolecules 3.4 Safety aspects in use of centrifuge **UNIT-4: SPECTROPHOTOMETRY** 4.1 Molecular absorption spectroscopy and Laws of photometry 4.2 Colorimeter : Components of the instrument and applications 4.3 Spectrophotometer: Single beam and double beam instrument and applications 4.4 Quantitative analysis by spectrophotometer-manual and automated
Reference Books	**REFERENCES:** 1. Keith Wilson &john walker (ED) (2000): Practical biochemistry-principle & Techniques. Cambridge university press. 2. Skoog , Holler and Nieman, Industrial analysis-Saunders college publication 3. Skoog, West and Holler, fundamentals of analytical chemistry- Saunders college publication 4. James S. Fritz & George H. Schenk, Jr. (1969): Quantitative analytical chemistry (2nd edition). Allyn &Bacon, Inc., Boston. 5. Brown S.B (1980): An Introduction to spectroscopy for biochemists. Academic press London. 6. E.D.P.De Robertis& E.M.F. De Robertis Jr.(2001): Cell and Molecular Biology (8th edn) Lippincott Williams & Wilkins, London 7. Robards K. Haddad P. R. & Jackson P.E. (1994): Principles and Practice of modern chromatographic methods. Academic press London
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: 06: Mammalian Anatomy and Physiology

Course Code	**BT-06**
Course Title	**Mammalian Anatomy and Physiology**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The Purpose of Course is to make students aware regarding many Anatomical and Physiological processes of many systems in Mammals.

Course Objective	To make students acquainted with concepts regarding structure and functions of various systems in Mammals.
Course Outcomes	CO1: Explains students the structure of Muscles in Mammals, their structure and physiology. It also explains the Cardiac physiology. Students gets knowledge regarding the working of muscles and Heart. CO2: The students gets information regarding the structure and function of Nervous system. They are also taught regarding the different kinds of Neurotransmitter, Reflex activities and how the signal pasees at synapses. CO3: Explains in detail the physiology of Reproductive system in Mammals. Students gets the knowledge regarding the process of formation of Gametes and Fertilization. CO4: It also explains the physiology and products of Clevage. CO5: This Course also gives the detail knowledge of various Endocrine glands, their structure and function.
Mapping between COs with PSOs	
Pre-requisite	Basic science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■
CO5	■		■		■	■

Course Content	**UNIT-1: MUSCLE PHYSIOLOGY & CARDIO-VASCULAR SYSTEM** 1.1 Structure & Types of Muscles 1.2 Structure & Internal Anatomy of Heart 1.3 Organization & Microscopic anatomy of Skeletal Muscle Fiber 1.4 Sliding Filament Mechanism of Skeletal Muscle Fibers 1.5 Cardiac cycle & Cardiac Output **UNIT-2: NEUROPHYSIOLOGY** 2.1 Structure & types of Neurons & Nerve Fibers 2.2 Neurotransmitters 2.3 Reflex Activities 2.4 Electrical Signals in Neurons 2.5 Synapse & Signal transmission at Synapse **UNIT-3: EMBRYOLOGY & REPRODUCTIVE SYSTEM** 3.1 Structure of Testis & Ovary with role of their hormones 3.2 Spermatogenesis & Oogenesis 3.3 Fertilization 3.4 Characteristics, Planes, Physiology & Products (Morula, Blastula & Gastrula) Of Cleavage 3.5 Female Reproductive Cycle **UNIT-4: ENDOCRINOLOGY** 4.1 Introduction to Endocrine Glands & Hormones 4.2 Pituitary Gland – Structure, Hormones & their functions 4.3 Thyroid & Parathyroid Glands - Structure, Hormones & their functions 4.4 Adrenal Gland – Structure, Hormones & their functions 4.5 Pancreas – Structure, Hormones & their functions

Reference Books	**REFERENCES:** 1. Anatomy & Physiology – G. J. Tortora & B. Derrickson, Wiley Pub. 2. Medical Physiology – Guyton & Hall, Saunders Elsevier Pub. 3. Essentials of Medical Physiology – K. Sembulingam & P. Sembulingam, Jaypee Brothers Medical Pub. 4. Chordate Embryology - P. S. Verma & V. K. Agarwal, S. Chand Pub. 5. Developmental Biology – S. F. Gilbert, Palgrave Macmillan Pub.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: 07: PLANT MORPHOLOGY AND PHYSIOLOGY

Course Code	**BT-07**
Course Title	**PLANT MORPHOLOGY AND PHYSIOLOGY**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The purpose of the course is to make the student to get basic knowledge about plant, relations among plant & water, some metabolic processes occurs in plants & also get information regarding growth & amp regulation of nutrients in plants.
Course Objective	To give an overview of plant system – Root & shoot system To Describe the Structure of seed & chloroplast To explain the Modification of root , Fertilization & Germination of Seed To explain role of different nutrients in plants.
Course Outcomes	CO1: Students knows different system of the plant & also gets Knowledge Of the parts of the plants. CO2: Students gets knowledge related water, relation of plant -Water. CO3: Students gets idea about different pathways some metabolic process in plants. CO4: They also knows growth & regulation of the plants .
Mapping between COs with PSOs	
Pre-requisite	Basic science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	■							
CO2	■		■					
CO3	■	■	■		■			
CO4		■	■	■		■	■	■
CO5	■		■		■	■		
CO6	■	■		■		■	■	■

Course Content	**UNIT-1: PLANT MORPHOLOGY** 1.1 Shoot system - Parts and functions 1.2 Root system- types, functions and modifications 1.3 Flower- Parts, functions, types of fertilizations, fruit formation. 1.4 Seed-Types, basic structure. Germination- types, factors necessary for germination. **UNIT-2: PLANT-WATER RELATIONS** 2.1 Water relations- Diffusion, Osmosis, water potential and its components 2.2 Turgor pressure, Wall pressure and interrelationship. 2.3 Ascent of sap-Theories 2.4 Transpiration - types, Mechanism of opening and closing of stomata, factors influencing transpiration rate. **UNIT-3: METABOLIC PROCESSES** 3.1 Structure of chloroplast; Action spectra, Photophosphorylation. 3.2 Pathways of carbon fixation- C3, C4, CAM pathway; Significance of Carbon fixation. 3.3 Photorespiration and its significance 3.4 Mineral salt absorption- Passive absorption and active absorption. **UNIT-4: GROWTH AND REGULATION** 4.1 Mineral nutrition: Macro, and micronutrients, their role, deficiency symptoms. 4.2 Growth pattern and kinetics, Physiological role of Phytohormones- Auxins, Kinetin, Gibberellins, ABA and Ethylene: Their applications. 4.3 Concept of photomorphogenesis -Phytochrome system, Photoperiodism. 4.4 Vernalization, Florigen concept.
Reference Books	**REFERENCES:** 1. A. C. Dutta 6th Edition, Botany for Degree Students *Publisher*: Oxford. 2. Frank B. Salisbury and Cleon W. Ross (2010), Plant Physiology, Cengage learning products, India Edition. 3. S. K. Verma and Mohit Verma (1999) Plant Physiology Biochemistry and Biotechnology, S. Chand. 4. Lincoln Taiz and Eduardo Zaiger (4th Edition), Plant Physiology, Sinqaur Associates Inc. Publishers. 5. S. N. Pandey and K. K. Singh, Plant physiology, Vikas Pub.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: 03: BTP-03: Biotechnology Practical

Course Code	**BT-03**
Course Title	**Biotechnology Practical**
Credit	3
Teaching per Week	6Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019

<table>
<tr><td>Purpose of Course</td><td>To provide hand’s on experience of using instruments in the laboratory for biotechnology purpose.</td></tr>
<tr><td>Course Objective</td><td>Biotechnology is practical based course so main objective of this course is to acquaint students about how to use laboratory instruments, perform cell counting and other basic details.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: To learn how to prepare different solutions and calibration of pH. Outcome would be how to handle pH meter
CO2: To learn how to count cells and use binocular microscope. Outcome would be how to use haemocytometer.
CO3&CO4: To learn how to use centrifuge and spectrophotometer. Outcome would be how to analyze biomolecules
CO5: To learn Paper chromatography technique. Outcome would be how to perform separation of different biomolecules.
CO6: To learn working of different instruments, understand difference between Reaction Time & Reflex action as well different stages of differentiation. Outcome would be to know principles on which different instrument works.
CO7: These practical’s are related to Botany in which student learn about study of plasmolytic method, photosynthesis, differences in C3 and C4 plants. Outcome would be to know how to determine OP and learn that oxygen evolves during phosynthesis.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td>■</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td>■</td><td></td><td>■</td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td>■</td><td>■</td><td>■</td><td></td><td>■</td><td></td></tr>
<tr><td>CO4</td><td></td><td>■</td><td>■</td><td>■</td><td></td><td>■</td></tr>
<tr><td>CO5</td><td>■</td><td></td><td>■</td><td></td><td>■</td><td>■</td></tr>
<tr><td>CO6</td><td>■</td><td>■</td><td></td><td>■</td><td></td><td>■</td></tr>
<tr><td>CO7</td><td>■</td><td>■</td><td></td><td>■</td><td></td><td>■</td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic science</td></tr>
</table>

<table>
<tr><td>Course Content</td><td>1. Preparation of working solutions as well as different buffers and calibration of pH meter.

2. Study of Binocular Microscope and cell count by Haemocytometer.

3. To study the working of Centrifuge.

4. To study the working of Spectrophotometer.

5. Paper chromatography for separation of amino acids.

6. To study use & working of Electrocardiogram (ECG), Electroencephalogram (EEG), Sphygmomanometer, Electromyogram & Kymograph Apparatus.

7. To study Reaction Time & Reflex Action.

8. To study planes of cleavage, morula, blastula & gastrula with the help of permanent slides/charts/photographs.

9. Determination of osmotic potential of cell sap by plasmolytic method.</td></tr>
</table>

	10. Comparatively anatomical studies of C3 and C4 plants. 11. Experiment to show that oxygen is evolved during photosynthesis. 12. To compare the loss of water from two surfaces of leaf by: a) CoCl2 method b) Four leaf method
Reference Books	1. Patel RJ, Patel KR. Experimental microbiology Part II. Aditya Publication, Ahmedabad. 2016. 2 Abhijit Dutta Experimental Biology A laboratory manual.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

B.Sc. 4rd Semester

BT-08: FUNDAMENTALS OF MYCOLOGY

Course Code	**08**
Course Title	**FUNDAMENTALS OF MYCOLOGY**
Credit	3
Teaching per Week	6Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The purpose of the course is to provide insights about basics of fungal kingdom, morphology, characteristics, relationship and applications
Course Objective	To acquaint students with the concepts of mycology (study of fungi)
Course Outcomes	CO1: To acquaint students with classification of fungal kingdom, characteristics of fungi and morphology. CO2: To elaborate on fungal physiology and differentiation. Students will gain insights on fundamentals of fungal growth requirements, cellular reproduction, mould-yeast dimorphism etc. CO3: Students will acquire concepts of control of fungal growth. Provide insights of management of environmental and biological factors, mode of action of anti-fungal agents and brief idea about fungal infections in humans. CO4: Students will gain fundamentals of fungal relationships like parasitism, symbiosis, saprotrophism. Students will acquire knowledge pertaining to role of biotechnology in mycology.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						

	CO3 ■ ■ ■ ■ ■ ■ CO4 ■ ■ ■ ■ ■ ■
Pre-requisite	Basic science

Course Content	**UNIT-1: INTRODUCTION** **1.1** Place of fungi in 'tree of life'. **1.2** Characteristics of fungi. **1.3** Morphology of yeasts and filamentous fungi. **1.4** Classification of fungi. **1.5** Life cycle of the yeast *Saccharomyces* and filamentous Ascomycetes. **UNIT-2: FUNGAL PHYSIOLOGY & DIFFERENTIATION** **2.1** Physical & Chemical requirements for growth. **2.2** Fungal cultivation media. **2.3** Cellular reproduction. **2.4** Mould-yeast dimorphism. **2.5** Sclerotia & Nutrient –translocating organs. **UNIT-3: CONTROL OF FUNGAL GROWTH** **3.1** Management of environmental and biological factors. **3.2** Biological and chemical control. **3.3** Cellular targets of antifungal agents. **3.4** Fungicides for plant disease control. **3.5** Control of fungal infections of humans. **UNIT-4: APPLIED MYCOLOGY** **4.1** Fungal parasites and symbionts of plants. **4.2** Fungal pathogens of humans. **4.3** Fungal parasites as biological control. **4.4** Fungal saprotrophs. **4.5** Fungi in Biotechnology and Case study-Hepatitis B vaccine.
Reference Books	**REFERENCES:** 1. Deacon, J. (2007). *Fungal Biology*. 4th Ed., Blackwell Publishing. 2. Kavanagh, K. Ed. (2006). *Fungi: Biology and Applications*. Wiley. 3. Wiley, J., & Sherwood, L. (2011). *Prescott's Microbiology*, 8th Ed., McGraw-Hill Science/Engineering/Math.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT-09: FUNDAMENTALS OF IMMUNOLOGY

Course Code	**09**
Course Title	**FUNDAMENTALS OF IMMUNOLOGY**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019

<table>
<tr><td>Purpose of Course</td><td>The Immunology course aims to provide an adequate understanding about the fundamentals of the immune system and the students gain knowledge about the features and mechanisms of innate and adaptive immune response. Be able to compare and contrast the innate versus adaptive immune systems</td></tr>
<tr><td>Course Objective</td><td>To make students understand the organization of the immune system and host resistance against an invading organism. to provide students with a foundation in immunological processes</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Explain students the insight of the immune system, physical barriers in non-specific resistance and organs and tissues of the immune system. A description of cells involved in the immune response either innate or acquired.
CO2: Students gain understanding about processes of phagocytosis and inflammation.
CO3: The course also explains the chemical mediators in non-specific resistance like cytokines, complement, acute-phase proteins and antimicrobial peptides.
CO4: To provide an adequate knowledge about antigens, T cell biology, types of specific immunity and recognition of foreignness.
CO5: To gain a deep knowledge about B cell biology, Immunoglobulin structure, function and classes.
CO6: Explain students how antibodies take action, antibody kinetics and generation of antibody diversity.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic science</td></tr>
</table>

<table>
<tr><td>Course Content</td><td>UNIT 1: INTRODUCTION TO IMMUNE SYSTEM
1.1 Overview of host resistance
1.2 Cells of the immune system
1.3 Organs and Tissues of the immune system
1.4 Physical barriers in non-specific resistance

UNIT 2: NON-SPECIFIC HOST RESISTANCE
2.1 Phagocytosis
2.2 Inflammation
2.3 Chemical mediators in non-specific (Innate) resistance
2.3.1 Antimicrobial peptides
2.3.2 Complement
2.3.3 Cytokines
2.3.4 Acute-Phase proteins

UNIT 3: SPECIFIC HOST RESISTANCE-I
3.1 Overview of specific immunity
3.2 Antigens
3.3 Types of specific immunity
3.4 Recognition of Foreignness
3.5 T Cell Biology

UNIT 4: SPECIFIC HOST RESISTANCE-II
4.1 B cell Biology</td></tr>
</table>

	4.2 Immunoglobulin Structure, Function and Classes 4.3 Generation of Anitbody Diversity 4.4 Antibody kinetics 4.5 Action of Antibodies
Reference Books	**REFERENCES:** 1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J., (2008). *Prescott, Harley & Klein's Microbiology*, 7Ed, The McGraw-Hill Companies, Inc.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT-10: INTRODUCTION TO MOLECULAR BIOLOGY

Course Code	**BT-10**
Course Title	**INTRODUCTION TO MOLECULAR BIOLOGY**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	The purpose of this course is to impart students the basic principles, concepts and mechanisms about genetic material.
Course Objective	To introduce to the students how DNA replicates, mutates, repairs and recombine in both prokaryotic and eukaryotic organisms
Course Outcomes	CO1 : This unit deals with DNA replication. Outcome of this would be that students would be aware of how replication of genetic material occurs and mechanisms which regulate this mechanism CO2 : Second unit is DNA mutations and Repair. Knowledge about how DNA gets mutated and repaired would be imparted to the students. CO3 : Third unit is about Molecular recombination and Gene Transfer-I. The outcome would be the knowledge of recombination, transposable elements and plasmids at molecular level. CO4 : Fourth unit is extension of third unit with more details. Expected outcome of the unit would be the knowledge about important events like conjugation, transformation and transduction in prokaryotes.
Mapping between COs with PSOs	
Pre-requisite	Basic Science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■				■
CO2		■	■	■	■	■
CO3	■				■	■
CO4	■		■	■		

Course Content	**UNIT-1: DNA REPLICATION** 1.1 General features of DNA replication 1.2 Replication in prokaryotes 1.3 Replication in eukaryotes 1.4 Termination of replication

	1.5 Regulation of replication **UNIT-2: DNA MUTATIONS AND REPAIR** 2.1 Chemical basis of mutations 2.2 Spontaneous and Induced mutations 2.3 Effect of mutations 2.4 Detection and Isolation of mutants 2.5 DNA repair **UNIT-3: MOLECULAR RECOMBINATION AND GENE TRANSFER-I** 3.1 Introduction to recombination and recombination in eukaryotes 3.2 Horizontal gene transfer in prokaryotes 3.3 Recombination at molecular level 3.4 Transposable elements 3.5 Bacterial plasmids **UNIT-4: MOLECULAR RECOMBINATION AND GENE TRANSFER-II** 4.1 Bacterial Conjugation 4.2 Bacterial Transformation 4.3 Transduction 4.4 Development of antibiotic resistance in bacteria 4.5 Mapping the genome
Reference Books	**REFERENCES:** 1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J., (2008). *Prescott, Harley & Klein's Microbiology*, 7Ed, The McGraw-Hill Companies, Inc.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BTP-04: Biotechnology Practical

Course Code	**BT-04**
Course Title	**Biotechnology Practical**
Credit	3
Teaching per Week	6 Hrs
Minimum weeks per Semester	15 (Including Class work, examination, preparation, holidays etc.)
Effective From	June 2019
Purpose of Course	To give basic practical knowledge of mycology immunology,biotechnogy and biochemistry
Course Objective	Students develop basic practical skills for above subjects
Course Outcomes	CO1 :basic skill for fungal growth and identification CO2 : basic knowledge about blood grouping CO3 : are able to identify different types of blood cells CO4 : makes able the students for quantitative biochemistry experiment CO5; make student able to understand basic biotechnology skills
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						

	CO2 CO3 CO4 CO5
Pre-requisite	Basic Science

Course Content	1. Cultivation and identification of moulds on different mycological media. 2. Isolation and cultivation of yeast. 3. Study of different spores produced by *Puccinia graminis* using permanent slides. 4. Isolation of plant pathogenic fungi from the Red Rot of Sugarcane. 5. Differential Count of blood leucocytes. 6. Diagnosis of Syphilis by Rapid Plasma Reagin (RPR) Test. 7. Study of Haemagglutination in blood grouping. 8. Extraction of bacterial plasmid by alkaline lysis method. 9. Isolation of Prokaryotic DNA. 10. Estimation of DNA by DPA method. 11. Estimation of RNA by Orcinol method. 12. Study of pigmentation mutation in *Serratia marcescens*
Reference Books	1. Patel RJ, Patel KR. Experimental microbiology Part II. Aditya Publication, Ahmedabad. 2016. 2. S.K.Sawhney Randhir Singh Introductory practical Biochemistry.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

M. Sc. Integrated Biotechnology V to VI

Name of Program	**M. Sc. Integrated Biotechnology**
Abbreviation	**BT**
Duration	**3 Years**

Medium of Instruction		English						
Program Structure		Semester V						
Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal Marks**	**Total Marks**
		Theory	**Practical**		**Duration**	**Marks**		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	12	0	12	2x6 Hrs	50	20	70
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	BTP 05	0	12	6	3 × 5 Hrs	120	120	240
	Total	18	12	24	33 Hrs	320	200	520
Program Structure		Semester VI						
Course Code	**Title**	**Teaching per week**		**Course Credits**	**University Examination**		**Internal Marks**	**Total Marks**
		Theory	**Practical**		**Duration**	**Marks**		
	Foundation Compulsory	2	0	2	2 Hrs	50	20	70
	Generic Elective	2	0	2	2 Hrs	50	20	70
	Core 1	12	0	12	2x6 Hrs	50	20	70
	Foundation Elective	2	0	2	2 Hrs	50	20	70
	BTP 06	0	12	6	3 × 5 Hrs	120	120	240
	Total	18	12	24	33 Hrs	320	200	520

Course Code	**BT-11**
Course Title	**Immunotechnology**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020

<table>
<tr><td>Purpose of Course</td><td>The course of immunotechnology aims at the application of basic aspects of the immune system for diagnostics and therapeutics as well as the generation of vaccines for different diseases of mankind.</td></tr>
<tr><td>Course Objective</td><td>• To learn about the production of various diagnostic tools like monoclonal antibodies and other methods that involves the immune system for disease detection.
• To learn about various types of autoimmune disorders and a variety of vaccines.</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : The unit covers techniques used in the generation and application of monoclonal antibodies for disease diagnosis and therapeutic purposes.
CO2 : Students will learn about various types of antigen-antibody reactions as well as analytical techniques used in the field of clinical/serological diagnosis.
CO3 : The unit gives a brief account of various types of hypersensitivity reactions, various types of disorders generating due to hypersensitivity reactions, autoimmune diseases types and examples, immunodeficiency disorders.
CO4 : This unit focuses on different types of vaccines: their production and application as a preventive means against various infections.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1: MONOCLONAL ANTIBODIES
1.1 Hybridoma Technology
1.2 Myeloma tumours
1.3 Procedure for generation of hybridomas
1.4 Human monoclonal antibodies
1.5 Chimeric Monoclonal Antibodies
1.6 Application of monoclonal antibodies
1.7 Monoclonal antibodies as Abzymes

UNIT-2: TECHNIQUES USED IN DIAGNOSIS
2.1 Precipitation
2.2 Agglutination
2.2.1 Haemaglutination
2.2.2 Bacterial agglutination
2.2.3 Passive agglutination
2.2.4 Agglutination inhibition
2.3 ELISA
2.4 Radioimmunoassay
2.5 Immunofluorescence
2.6 Immunochromatography 3

UNIT-3: HYPERSENSITIVITY & IMMUNE DISEASES
3.1 Hypersensitivity Type I, II, III & IV
3.2 Autoimmune diseases: Introduction, Types, Insulin Dependent Diabetes Mellitus and Rheumatoid Arthritis
3.3 Immunodeficiency: Introduction, Types, Severe Combined Immunodeficiency
UNIT-4: VACCINES
4.1 Attenuated and killed vaccines</td></tr>
</table>

	4.2 Subunit vaccine (Toxoids, Capsule polysaccharides, Glycoproteins) 4.3 Multivalent subunit vaccine 4.4 DNA vaccine 4.5 Recombinant vector vaccine
Reference Books	Kuby Immunology –Janis Kuby, Kindst, Gatsby And Osborne, 6th Edition, W. H. Freeman Publications. Immunology And Immunotechnology- Ashim Chakravarty, Oxford University Press, ISBN-13: 978-0-19-567688-4 Microbiology- Lansing Prescott, John P. Harley, Donald A. Klein, 8th Edition, Mcgraw Hill Publication. Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, 7th Edition, Cambridge University Press.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BT-12**
Course Title	**Clinical Hematology**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	This course will introduce the study of the hematopoietic system including the relationship of hematologic diseases to diagnostic characteristics.
Course Objective	• Fundamental understanding of blood and related diseases. • Explain the importance of cellular or morphological characteristics of blood cells. • Differentiate and enumerate cells on a peripheral blood smear. • Explain the principles and methods of each test performed in the laboratory and the clinical significance.
Course Outcomes	CO1: Students will understand the cause, prognosis, treatment and prevention of diseases related to study. CO2: Students can focus on study of various tests of blood. For example, CBC (Complete Blood Count) test, this gives information on red blood cells, white blood cells and platelets. To make the proper functioning of the body, each type of blood cells need to perform well, and they have their own set of functions. CO3: The unit immunohematology, ABO blood groups, its types and importance of blood grouping specially for blood transfusion. CO4: The unit focuses on blood banking- it is the process that takes place in the laboratory to make sure that donated blood or its products which are safe before they are used in blood transfusions. Students will study about various components of blood, blood donors and various tests done in blood banking.

<table>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>
UNIT-1: Introduction to Hematology
1.1 Introduction to hematology and blood
1.2 Hematopoietic system
1.3 Hemoglobin derivatives
1.4 Classification of Anemia
1.5 Laboratory tests in iron deficiencies
1.6 The Thalassemia

UNIT-2: Methods in Clinical Hematology
2.1 Complete blood count
2.2 Complete hemogram
2.3 Collection of blood and anticoagulants
2.4 Routine hematology laboratory experiments
2.5 Hematology histograms

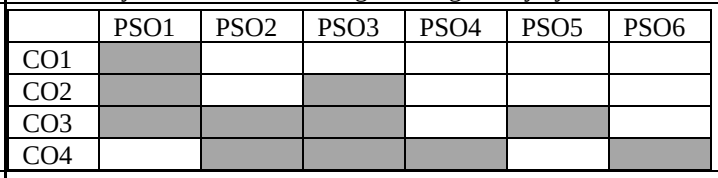
UNIT-3: Immunohaematology
3.1 Routine ABO Testing and ABO Antibodies
3.2 Inheritance of ABO Blood Groups
3.3 The Bombay Phenotype
3.4 Rh System: History, Molecular genetics and Clinical considerations
3.5 Introduction to ISBT blood group systems
3.6 The Cross matching tube test

UNIT-4: Blood Banking
4.1 Introduction to blood transfusion
4.2 Collection of blood from donor
4.3 Transfusion medicine
4.4 Selection of blood components
4.5 Use of blood derivatives; blood and blood component transfusions
4.6 Techniques used for the separation of blood constituents
</td></tr>
<tr><td>Reference Books</td><td>1. Godkar P, Godkar D. Textbook of Medical Laboratory Technology. 3rd Edition. Mumbai: Bhalani Publishing House; 2014.
2. Harmening D. Modern blood banking & transfusion practices. New Delhi: Jaypee; 2013.</td></tr>
<tr><td>Teaching Methodology</td><td>Classwork, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
<tr><td>Evaluation Method</td><td>30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination</td></tr>
</table>

<table>
<tr><td>Course Code</td><td>BT-13</td></tr>
<tr><td>Course Title</td><td>Nanobiotechnology</td></tr>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>This is fundamental course to bridge areas in physics, chemistry and biology. It provides an introduction to the emerging field of bio-nanotechnology. It introduces concepts in nano-materials and their use with bio-components to synthesize and address larger systems.</td></tr>
<tr><td>Course Objective</td><td>• To equip the students with the concepts of biotechnology required for understanding the behaviour of nano-materials and biomaterials.
• To foster the knowledge, how modern research is harnessing biological systems to further nanotechnological endeavour.
• How modern science is gaining knowledge from natural systems that construct and control at the nanoscale.
• How general principles of structure and function within biological systems are used to construct functional devices within nanotechnology.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Comprehend the concept of "nanotechnology" and its interdisciplinary aspects. Learn basic properties of nanomaterials. Identify different types of nano materials and its applications.
CO2: Learn various approaches of synthesizing nanomaterials, their advantages and limitations. Understand the mechanism of preparation of variety of nanomaterial. Choose the suitable method of synthesis for further applications.
CO3: Analyze different types of DNA based Nanostructures. Know the importance of bio-mimicry to fabricate protein based nanoarchitecture.
CO4: Learn about recent development in the area of devices and therapy. Learn about nano diagnostics. Identify the application of carbon nanostructure for different day-to-day applications.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1: INTRODUCTION TO NANOTECHNOLOGY & NANOBIOTECHNOLOGY
1.1 Introduction to Nano-world
1.2 Types and properties of nanomaterials
1.3 Introduction to nanobiotechnology
1.4 Dominion of biological machines
UNIT-2: SYNTHESIS OF NANOMATERIALS
2.1 Approaches for synthesis of nanoparticles
2.2 Techniques for synthesis of nanostructures
2.3 Self-assembly techniques
2.4 Introduction to biosynthesis
2.5 What is biosynthesis? Why biosynthesis?
UNIT-3: MOLECULAR NANOTECHNOLOGY
3.1 Mastering the complex DNA nanostructure
3.2 DNA tweezers</td></tr>
</table>

	3.3 DNA actuators 3.4 DNA scissors 3.5 Self-assembly of protein nanoarchitecture 3.6 Applications of protein nanostructures 7 **UNIT-4: APPLICATIONS OF NANOBIOTECHNOLOGY** 4.1 Application of carbon nanotubes in: 4.1.1 Diagnostic equipment 4.1.2 Surgical supplements 4.1.3 Tissue engineering 4.1.4 Gene delivery 4.1.5 Anti-carcinogenic activity 4.1.6 Drug delivery 4.1.7 Neurodegenerative disorder therapy 4.2 Use of liposomes 4.3 Photocatalysis of pollutants 4.4 Application in food and agriculture
Reference Books	1.Goodsell, David S. Bionanotechnology: Lessons from Nature. John Wiley & Sons, 2004. 2. Pradeep, T. A textbook of Nanoscience and Nanotechnology. Tata McGraw-Hill Education, 2003. 3. Sharon Madhuri et al Bio-nanotechnology, Ane Books Pvt. Ltd., 2012. 4.Kulkarni, Sulabha K. Nanotechnology: Principles and Practices. Springer, 2014. 5.Marulanda, Jose Mauricio, ed. Carbon Nanotubes: Applications on Electron Devices. BoD–Books on Demand, 2011.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BT-14**
Course Title	**Introduction to Molecular Biology-II**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	It is an advanced level course for the graduate students which gives a detailed account on transcription and translation with their regulatory aspects and also includes content imparting knowledge about protein maturation and post translational modifications.
Course Objective	To fetch knowledge about fundamental processes in detail at Molecular level. To understand the biochemistry of regulatory mechanisms controlling these fundamental processes. To get an idea on post-translational modifications and global regulatory networks.

Course Outcomes	CO1: This unit covers the concept of genetic codes and their features. It explains more about the transcription occurring in Bacteria, Eukaryotes and Archaea. CO2: This unit emphasizes on synthesis of proteins, how are these proteins modeled to give a correct form. It also explains further about protein maturation and how these proteins are targeted to their destination on secretion. CO3: The unit highlights about the levels of regulation involved in RNA and protein synthesis. It gives information on processes like splicing and RNA editing. It explains about the role of ubiquitylation and chaperon mediated protein folding. CO4: This unit provides information about regulation of genes in viruses additionally. It talks more about global regulatory systems.
Mapping between COs with PSOs	
Pre-requisite	Basic Science
Course Content	**UNIT-1: TRANSCRIPTION AND GENETIC CODE** 1.1 Transcription in Bacteria 1.2 Transcription in Eukaryotes 1.3 Transcription in Archaea 1.4 Establishment of Genetic Code 1.5 Characteristics of Genetic Code **UNIT-2: TRANSLATION** 2.1 tRNA and amino acid activation 2.2 Ribosome Structure 2.3 Initiation of Protein Synthesis 2.4 Elongation and Termination of Protein Synthesis 2.5 Protein maturation and secretion **UNIT-3: REGULATION OF GENE EXPRESSION-I** 3.1 Levels of Regulation 3.2 Regulation of Transcription initiation 3.3 Regulation of Transcription elongation 3.4 Regulation of Translation 9 **UNIT 4: REGULATION OF GENE EXPRESSION-II** 4.1 Post-translational Regulation 4.2 Global regulatory systems 4.3 Regulation of gene expression in Eukarya and Archaea 4.4 Gene regulation in Bacteriophage λ
Reference Books	Willey, J. M., Sherwood, L. M. and Woolverton, C. J. (2008). Prescott, Harley and Klein's Microbiology, 7th Edition, McGraw Hill International Edition
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BT-15**
Course Title	**Genetic Engineering**
Credit	2
Teaching per Week	2

<table>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>June 2020</td></tr>
<tr><td>Purpose of Course</td><td>It is an entry-level course imparting knowledge of genetic engineering to use different molecular biology techniques in order to create genetic modifications in different kind of organisms.</td></tr>
<tr><td>Course Objective</td><td>• Fundamental understanding of importance, need and implication of rDNA technology
• To understand know-how’s of rDNA technology, its tools and techniques.
• To understand generation, insertion, identification, and confirmation of cloned genes into different organisms.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Students will develop an understanding on basic idea of gene cloning, its importance, types of enzymes used as tools in gene cloning as being prime players.
CO2: As being carriers of genes of interest, students will understand about different types of vectors and comparative advantages offered by each of them so that proper choice of vector can be done.
CO3: Students will gain knowledge about techniques to insert prepared clones into different organisms and identification of recombinants.
CO4: The unit focuses on and thus provides knowledge of different techniques to, first, identify and then further validation of recombinants.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>3. Course Content
UNIT-1: RECOMBINANT DNA TECHNOLOGY AND ENZYMES
1.1 What is gene cloning and its importance
1.2 Range of DNA manipulative enzymes
1.3 Restriction Endonucleases
1.4 Ligation enzymes
UNIT-2: CLONING VECTORS
2.1 Vectors based on Plasmids.
2.2 Vectors based on M13
2.3 Vectors based on Phage Lambda
2.4 Vectors for Yeasts and other Fungi
2.5 Vectors for higher plants
2.6 Vectors for animals
UNIT-3: TECHNIQUES USED IN GENETIC ENGINEERING-I
3.1 Transformation
3.2 Identification of recombinants
3.3 Insertion of phage DNA
3.4 Introduction of DNA to non-bacterial cells 11

UNIT-4: TECHNIQUES USED IN GENETIC ENGINEERING-II
4.1 Colony and Plaque Hybridization
4.2 Practical uses of hybridization probing
4.3 Polymerase Chain Reaction: Outline, Details, Studying products, Real-Time PCR
4.4 DNA Sequencing: Chain termination, Shotgun, Clone Contig methods</td></tr>
</table>

Reference Books	Brown TA. Gene cloning and DNA analysis: an introduction. John Wiley & Sons; 2016 Jan 19.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BT-16**
Course Title	**Bioethics, Biosafety and IPR**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	Provide the basic knowledge regarding Bioethics, Biosafety and IPR.
Course Objective	• To acquaint, introduce & emphases students about Bioethics, Biosafety & IPR. • They will acquire adequate knowledge in the use of genetically modified organisms and its effect on human health, Stem cells, organ transplant etc. • They will gain more insights into the regulatory affairs & see the ethical side of scientific research. • They will be able to implement good lab practices & biosafety mechanisms.
Course Outcomes	CO1: To provide basic knowledge about concepts of Bioethics & Bio safety, their applications & significance. CO2: To provide awareness & understanding regarding ELSI of few of the latest research, technologies & advances of science & their impact on human life & society. CO3: Students will be made aware of different preventive methods & good biosafety practices. CO4: To inform students about IPR's basic & provide knowledge about different Acts, regulations, laws, policies etc.
Mapping between COs with PSOs	
Pre-requisite	Basic Science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	**UNIT-1: INTRODUCTION TO BIOETHICS AND BIOSAFETY** 1.1 Introduction and need of Bioethics and Biosafety 1.2 Applications of Bioethics 1.3 Applications of Biosafety 1.4 Bioethics and its relationship with other sciences 1.5 Levels of Biosafety (I to IV with respect to plant, animal and microbiology laboratories) **UNIT-2: INTRODUCTION TO ETHICAL, LEGAL AND SOCIAL IMPLICATIONS** 2.1 Human Genome Project 2.2 GMO: Foods & Crop 2.3 Stem Cell Research 2.4 Drug testing on Human volunteers 2.5 Organ transplantation **UNIT-3: BIOSAFETY** 3.1 Risk assessment 3.2 Containment 3.3 Handling and disposal of chemical hazardous waste 3.4 Handling and disposal of biological hazardous waste 3.5 Immunization and first aid for biotech laboratory workers **UNIT-4: INTELLECTUAL PROPERTY RIGHTS** 4.1 Introduction to IPR 4.2 Types of IPR 4.3 International framework for IP protection 4.4 GATT, WTO, WIPO and TRIPS 4.5 PVP and Farmers' Right 4.6 Prior Art 4.7 Patent Database: USPTO, EPO and IPO
Reference Books	Sateesh MK. Bioethics and biosafety. IK International Pvt Ltd; 2008 Aug 25. 1. Singh BD. Biotechnology expanding horizons. Kalyani publishers; 2007. 2. Ganguli P. Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill Publishing Company; 2001. 3. National IPR Policy | Department for Promotion of Industry and Internal Trade | MoCI | GoI [Internet]. Dipp.gov.in. 2020 [cited 19 June 2020]. Available from: https://dipp.gov.in/policies-rules-and-acts/policies/national-ipr-policy
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	**BTP-05**
Course Title	**Biotechnology Practical**
Credit	6
Teaching per Week	12
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020

<table>
<tr><td>Purpose of Course</td><td>Practicals are designed to address laboratory skills relevant to the fields of biochemistry, genetic engineering, clinical serology and hematology.</td></tr>
<tr><td>Course Objective</td><td>• To equip students with essential skills for the further explorations of bioterchnology research.
• To teach clincial laboratory skills of serology and hematology.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Fundametnal analytical skills for the assay of common biomolecules
CO2: Learning routine diagnostic methods in clinical serology
CO3: Learning common methods for the synthesis of metal nanoparticles and study their effect on cells
CO4: Learning essential laboratroy skills for genetic engineering
CO5: Skill of important tests performed in clinical haematology
CO6: Important experimental knowhow of dairy microbiology and virology experiments.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>1. Estimation of reducing sugars by Cole’s method
2. Estimation of reducing sugars by DNSA method
3. Estimation of proteins by Folin-Lowry method
4. Seperation of amino acids by TLC
5. Radial precipitation test (Mancini’s)
6. Detection of HIV by ELISA.
7. Detection of Hepatitis B surface antigen by direct ELISA.
8. Dreyer’s Tube test for diagnosis of Typhoid
9. Immunochromatography for diagnosis of Malaria/Typhoid.
10. Synthesis of AgNPs by using sodium citrate.
11. Synthesis of AgNPs by using fungal/bacterial methods.
12. In vitro study of antimicrobial activity of AgNPs against bacteria.
13. Isolation of plasmid DNA from E. coli.
14. Extraction and Purification of bacterial DNA using spin column.
15. Restriction digestion of plasmid vector.
16. Transformation of bacterial cells by CaCl2 method.
17. Blood Crossmatching test (Tube method)
18. Coombs Test (Indirect)
19. Study of milk quality by Methylene Blue Reduction Test
20. Enrichment and isolation of coliphages from sewage</td></tr>
<tr><td>Reference Books</td><td>1. Patel RJ, Patel KR. Experimental microbiology Part II. Aditya Publication, Ahmedabad. 2016.
2. Mu p Plummer DT. Introduction to Practical Biochemistry. Tata McGraw-Hill Education.</td></tr>
</table>

	3. Sambrrok J Fritsch EF Maniatis T. Molecular cloning a laboratory manual.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

B.Sc. 6 Semester

BT 17 Pharmaceutical Biotechnology

Course Code	**BT – 17**
Course Title	Pharmaceutical Biotechnology
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020- 2021
Purpose of Course	The purpose of the course is intended to provide the student with a working knowledge of the preparation, stability and formulation of different protein and peptide drugs such as antisense agents, transgenic therapeutics etc. Current FDA approved biotechnology drugs such as human insulin; growth hormones etc. will be discussed.
Course Objective	1. The knowledge gained in this course would be used to understand and evaluate the different pharmaceutical parameters of the current and future biotechnology related drugs and products on the market. 2. Novel formulation approaches for better delivery of biotechnology derived drugs, such as nasal sprays, liposomes and biodegradable polymer will be addressed. 3. The delivery of peptides and proteins by the parenteral, oral, transdermal and nasal routes of administration will also be discussed. 4. Drug Designing and development will be discussed. The process of Pharmacokinetics and Pharmacodynamics will also be discussed. 5. The field of Regulatory affairs will also be addressed.
Course Outcomes	CO1: Students will able to gain basic idea of Drugs, Bio-Pharmaceuticals and role of Biotechnology. CO2: Students will get an idea on drug delivery methods and mechanism. CO3: Students will come across understanding effect of drug on body is and how it metabolized. CO4: Able to understand aim of regulatory concept, its scope and methodology of approval of drug along with the ICH guidelines.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Pre-requisite	Basic Science
Course Content	**UNIT-1: PHARMACEUTICALS, BIOLOGICS & BIOPHARMACEUTICALS** 1.1 Introduction to pharmaceutical products 1.2 Biopharmaceuticals and pharmaceutical biotechnology 1.3 History of the pharmaceutical industry 1.4 The age of biopharmaceuticals 1.5 Biopharmaceuticals: Current status and future prospects **UNIT-2: DRUG DELIVERY & THERAPEUTICS** 2.1 Drug delivery 2.1.1 Liposome 2.1.2 Nasal spray 2.1.3 Biodegradable polymer 2.1.4 Osmotic 2.2 RNAi Therapeutics 2.3 Antisense Technology 17 2.4 Enzyme of Therapeutic value- Superoxide dismutase, DNAse 2.5 Hormone as therapy- Insulin **UNIT-3: DRUG DISCOVERY & DEVELOPMENT** 3.1 Drug discovery and development 3.2 Clinical pharmacology 3.3 Pharmakokinetics 3.4 Pharmacodynamics 3.5 Toxicology studies- Reproductive toxicity, Teratogenicity, Carcinogenicity **UNIT-4: REGULATORY AFFAIRS** 4.1 Food & Drug Administration 4.2 The investigational new drug application 4.4 Regulatory procedure 4.5 Role of regulatory affairs department 4.6 ICH guidelines
Reference Books	1. Walsh G. Pharmaceutical biotechnology: concepts and applications. John Wiley & Sons; 2013 Apr 25. 2. Rang HP. Drug Discovery and Development. Technology in Transition. 2012 Jul 20:3. 3. Ho RJ, Gibaldi M. Biotechnology and Biopharmaceuticals. Transforming Proteins and Genes into Drugs. 2003. 4. Jogdand SN. Medical biotechnology. Himalaya Publishing House; 2008. 5. Sobti RC, Pachouri SS. Essentials of biotechnology. Ane Books Pvt. Limited; 2009.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT 18 Introduction to bioinformatics

Course Code	**BT 18**
Course Title	Introduction to bioinformatics

<table>
<tr><td>Credit</td><td>2</td></tr>
<tr><td>Teaching per Week</td><td>2</td></tr>
<tr><td>Minimum weeks per Semester</td><td>15 (Including Classwork, examination, preparation, holidays etc.)</td></tr>
<tr><td>Effective From</td><td>2020 -2021</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course will give students an introduction to the basic techniques of Bioinformatics. Emphasis will be given to the application of bioinformatics and biological databases. The students will become familiar with the use of a wide variety of internet applications using sequence alignment tools, biological database and will be able to apply these methods in future studies and research work.</td></tr>
<tr><td>Course Objective</td><td>To make students more familiar with Bioinformatics.
1. To provide basic idea of Biological database and its types for the studies.
2. To study Homology, pairwise alignment and multiple sequence alignment and provide insight to perform comparative analysis of known and unknown sequences.
3. To create zest of learning and utilize NCBI web portal and Bioinformatics for better understanding of Biotechnology.</td></tr>
<tr><td>Course Outcomes</td><td>CO1 :The unit convey students about understanding of Bioinformatics and its component along with its utility in Biotechnology.
CO2 :The unit will explore students towards biological database and its scope for study of literature and as well as metabolic pathway database.
CO3 : The unit consider the pairwise sequence alignment and explain the analysis of concept of similarity along with tools.
CO4 : The unit consider the multiple sequence alignment and explain the analysis of concept of checking similarity along with tools.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1: INTRODUCTION TO BIOINFORMATICS
1.1 A word on Bioinformatics
1.1.1 Branches of Bioinformatics
1.1.2 Aims of Bioinformatics
1.1.3 Scope and Research area of Bioinformatics
1.2 Organization of Bioinformatics in India
1.2.1 BTIS
1.2.2 Bioinformatics Server in India
1.2.2.1 Protein structure prediction server
1.2.2.2 Genomics and Proteomics server
1.2.2.3 Conformational epitope prediction server
1.3 Indian IT Companies involved in Bioinformatics Initiatives

UNIT-2: BIOLOGICAL DATABASE
2.1 Primary Database- Nucleotide sequence databases (EMBL, DDBJ, GenBank), Protein sequence databases (Swiss Prot, TrEMBL)
2.2 Secondary Database- Nucleotide sequence-TIGR, Protein sequence-PROSITE.
2.3 Structure Database- PDB, SCOPE, CATH 19
2.4 Metabolic Pathway Database- KEGG
2.5 Database retrieval tool- SRS, Entrez
2.6 Literature Database- PubMed</td></tr>
</table>

	UNIT-3: PAIRWISE SEQUENCE ALIGNMENT 3.1 Concept of Alignment - Global alignment, Local Alignment, Gap Penalty 3.2 Methods for sequence alignment: Dot matrix method, Dynamic Programming algorithm (Smith waterman & Needlemen Wunch algorithm). 3.3 Basic Local Alignment Search Tool 3.4 FASTA **UNIT-4: MULTIPLE SEQUENCE ALIGNMENT** 4.1 Introduction to Multiple sequence alignment. 4.2 Methods of Multiple sequence alignment (Sum of Pairs, Progressive, Iterative), 4.3 Application of Multiple sequence alignment. 4.4 Tools for Multiple sequence alignment: Clustal Omega.
Reference Books	1. Ghosh Z, Mallick B. Bioinformatics: Principles and Applications. Oxford University Press; 2008. 2. Attwood TK, Parry-Smith DJ. Introduction to bioinformatics. Essex, GB: Pearson Education; 1999. 3. Bosu O, Thukral SK. Bioinformatics: Experiments, Tools, Databases, and Algorithms. Oxford University Press, Inc.; 2007 Sep 6. 4. Murthy CSV. Bioinformatics. Himalaya Publishing House; 2016. 5. Rastogi SC, Rastogi P, Mendiratta N. Bioinformatics Methods And Applications: Genomics Proteomics And Drug Discovery 3Rd Ed. PHI Learning Pvt. Ltd.; 2008.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT 19 Microbiology Biotechnology

Course Code	**BT 19**
Course Title	**Microbiology Biotechnology**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 – 2021
Purpose of Course	The purpose of the course is intended to provide the student with a working knowledge of the Microorganisms and their role in biotechnological process such as Fermentation. The course involved discussion from designing of fermenter to strain improvement for fermentation industries..
Course Objective	1. To understand the commercial applications of microorganisms. 2. To learn concept of isolating enzyme and antibiotic producing microorganisms. 3. Acquire the ability and knowledge to isolate and screen the commercially important bacteria from different sources. 4. Understand how microbes are useful to human beings and how their

<table>
<tr><td></td><td>products are commercialized.
5. The designing of fermenter and role of each component will be explored.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: This unit explain students about basics of fermentation technology.
CO2: Through this unit students will get knowledge on microbial culture preservation and screening.
CO3: Students will come across understanding how to improve microbial strain for the better production of product.
CO4: By studying this unit students are able to understand design of fermenter for microbial biotechnology perspective.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1: INTRODUCTION TO MICROBIAL FERMENTATION
1.1 Concept of fermentation technology
1.2 Chronological development of industrial fermentation technology
1.3 Range of fermentation processes and products
1.4 Fermentation process outline
1.5 Fermentative production of Citric acid, Ethanol and Penicillin (Outline)

UNIT-2: MICROBIAL SCREENING AND PRESERVATION
2.1 Concept of microbial screening
2.2 Primary and Secondary screening
2.3 Isolation of industrially important microorganisms:
2.3.1 Methods utilizing selection of desired characteristics
2.3.2 Methods not utilizing selection of desired characteristics
2.4 Future potential and needs of microbial screening
2.5 Maintenance and Preservation of Microbial cultures 21

UNIT-3: IMPROVEMENT OF MICROORGANISMS
3.1 Types of Microbial mutants and their practical implications
3.2 Isolation of microbial mutants (Outline).
3.3 Selection of mutants producing high yield of primary & secondary metabolites
3.4 Parasexual cycle
3.5 Protoplast fusion

UNIT-4: FERMENTOR DESIGN
4.1 Basic functions of fermentor
4.2 Aseptic operation and Containment
4.3 Factors involved in fermentor design
4.4 Typical batch fermentor
4.5 Air-lift bioreactor and CSTF</td></tr>
<tr><td>Reference Books</td><td>1. Stanbury PF, Whitaker A, Hall SJ. Principles of fermentation technology. Elsevier; 2013 Oct 22.
2. Crueger W, Crueger A. Biotechnology: A Textbook of Industrial Microbiology. Madison: Sinauer Tech.; 1989.
3. Patel AH. Industrial microbiology. Macmillan India; 1984.</td></tr>
<tr><td>Teaching Methodology</td><td>Classwork, Discussion, Self-Study, Seminars and/or Assignment</td></tr>
</table>

Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT 20 Environmental Biotechonology

Course Code	BT 20
Course Title	Environmental Biotechonology
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 – 2021
Purpose of Course	The purpose of the course is Environmental Biotechnology combining biology with professional engineering wherein students are made aware of protecting and save environment; with use of bioremediation techniques using microbes, waste disposal into the environment and energy production using microorganisms.
Course Objective	1. To provide basic knowledge related to energy production using varieties of microorganisms. 2. To understand the concept of environmental bioremediation techniques and different microbes and plants that can be used for the same purpose. 3. To understand the role of microorganisms in waste treatment, characterize waste according to its hazardous nature and accordingly manage and dispose it. 4. To learn about bioleaching, metal precipitation and biopolymers and their uses. 5. Syllabus will help the students for making their career in the field of Environmental biotechnology, help in the research for using varieties of different organisms for bioremediation and waste treatment technologies.
Course Outcomes	CO1 :Students will learn about the organism's metabolic processes and their byproducts which can be used as energy sources. CO2 : Students will develop an understanding related to bioremediation, how it is helpful in treating environmental pollution problems and various bioremediation techniques. CO3 : Students will learn about the waste characterization based on their nature, use of aerobic and anaerobic techniques for waste treatment, and use of earthworms in increasing soil fertility by complete degradation of waste CO4 : This unit covers the processes such as Bioleaching, metal precipitation and biopolymers where students will learn about various microbes which can be used for bioleaching, metal precipitation and their removal from effluents and thereby from leaking into the environment and production of biopolymers and their uses.
Mapping between COs with PSOs	
Pre-requisite	Basic Science

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■					
CO2	■		■			
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	**UNIT-1: BIOENERGY** 1.1 Energy resources 1.2 Biogas technology 1.3 Bioethanol production from cellulosic waste 1.4 Microbial Hydrogen production 1.5 Biodiesel from Jatropha **UNIT-2: BIOREMEDIATION** 2.1 Principles of bioremediation 2.2 Factors responsible for bioremediation 2.3 Bioremediation strategies: *In situ* & *Ex situ* 2.5 Metal & Organic Phytoremediation 23 **UNIT-3: WASTE MANAGEMENT** 3.1 Characteristics of waste water 3.2 Aerobic biological waste water treatment: Activated sludge and Oxidation ponds 3.3 Anaerobic biological waste water treatment: UASB and Anaerobic baffled reactor 3.4 Conventional solid waste treatment technologies 3.5 Municipal waste management rules 3.6 Composting: Design aspects and process 3.7 Vermicomposting **UNIT-4: SOME SPECIAL PROCESSES** 4.1 Abatement of Air pollution 4.2 Bioleaching: Types and Methods 4.3 Metal Precipitation 4.4 Biopolymers: Types and Preparation 4.5 Properties and Practical applications of PHA
Reference Books	1. Fulekar MH. Environmental biotechnology. CRC Press; 2010 Jul 19. 2. Thakur IS. Environmental Biotechnology. IK International, New Delhi. 2006. 3. Pepper IL, Gerba CP, Gentry TJ, Maier RM, editors. Environmental microbiology. Academic press; 2011 Oct 13.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT 21 Plant Biotechnology

Course Code	**BT 21**
Course Title	**Plant Biotechnology**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020 – 2021
Purpose of Course	The purpose of the course is to understand the core concepts and fundamentals of plant biotechnology specifically plant tissue culture in order to promote in-vitro cultivation of different plant parts. This course will further augment student

<table>
<tr><td></td><td>knowledge about different techniques utilized for conservation and mass propagation of rare and endangered plant species and medicinal plants.</td></tr>
<tr><td>Course Objective</td><td>1. Key concept and understanding of media and nutrients, plant growth regulators needed to propagate tissue culture derived plants.
2. Thorough knowledge to grow, maintain and manipulate plant material in a laboratory setting for research and breeding purposes
3. To understand possible applications and limitations of different techniques utilized in plant tissue culture.</td></tr>
<tr><td>Course Outcomes</td><td>CO1 : Students will learn about historical perspective of plant tissue culture, plant tissue culture laboratory requirements and basic plant tissue culture media preparation and its significance.
CO2 : Whole unit focuses on one of the most important method of plant tissue culture i.e. Micropropagation, its types, advantages and limitations.
CO3 : Students will learn about types of in vitro embryogenesis, its culture conditions and its practical applications. They also learn about new other means of plant tissue culture i.e. synthetic seed technology and few preservation techniques.
CO4 :The unit focuses on different tissue culture techniques for haploid plant production in detail.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td><table><tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr><tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Pre-requisite</td><td>Basic Science</td></tr>
<tr><td>Course Content</td><td>UNIT-1:
1.1 Introduction and History of Plant tissue culture.
1.2 Laboratory Requirement and General Techniques.
1.3 Tissue culture Media (Murashiage and Skoog, Gamborg, Rosinni) Preparation, role of different media constituents and natural extracts.
1.4 Cellular Differentiation and Totipotency.

UNIT-2:
2.1 Micropropagation- Introduction, advantages and limitations.
2.2 Micropropagation (Direct organogenesis).
2.3 Micropropagation (Indirect organogenesis).

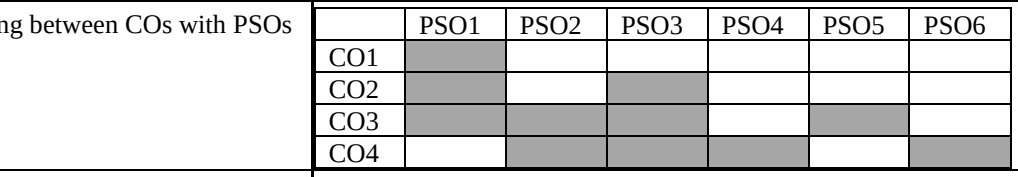
UNIT-3:
3.1 In vitro Embryogenesis: Somatic and Zygotic embryo culture conditions and practical applications.
3.2 Synthetic seeds – Classification, Encapsulation, Advantages limitations and Applications.
3.3 Cryopreservation and Germplasm conservation. 25

UNIT-4:
4.1 Haploid Production- Anther, Pollen, Ovary and Ovule Culture.
4.2 Factors affecting androgenesis and gynogenesis, Applications and Limitations.
4.3 Protoplast isolation and Culture-Methods of Isolation, Factors affecting Isolation, Purification and steps involved in culture.
4.4 Single cell culture.</td></tr>
</table>

Reference Books	1. Chawla H. Introduction to plant biotechnology (3/e). CRC Press; 2011 May 24. 2. Bhojwani SS, Razdan MK. Plant tissue culture: theory and practice. Elsevier; 1986 Jul 1. 3. Jha TB. Plant tissue culture: basic and applied. Universities Press; 2005. 4. Veeresham C, Kokate CK. Medicinal plant biotechnology. CBS Publishers and Distributers; 2006. 5. Razdan MK. Introduction To Plant Tissue Culture, 2/E. Oxford and IBH publishing; 2002.
Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BT 22 Animal Biotechnology

Course Code	**BT 22**
Course Title	**Animal Biotechnology**
Credit	2
Teaching per Week	2
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is
Course Objective	1. This course includes knowledge about techniques used in culturing of Animal cells in *in vitro* environment. 2. It is designed to give basic information about Animal Biotechnology subject, use of animal cell culture methods, various laboratory Equipments and procedures. 3. It gives the basic understanding of the way cell performs in the cultural environment and applications of cultured cells. 4. The syllabus also focuses on different tools and techniques applied in the field of assisted reproduction and in vitro fertilization.
Course Outcomes	CO1: This covers an introductory part of Animal Biotechnology where students get familiar with the basics of animal cell and tissue culture also the equipments used while culturing animal cells. The unit focuses on various advantages of studying Animal Biotechnology like – way to control the culture environment, characterization and homogenization of cultured cells etc. One can also learn different types of Animal cell culture techniques used in laboratory like – Adherent culture, Suspension culture and many more. CO2: Students will learn the general biological features of cells inside culture environment, their behaviour, metabolism and proliferation in *in vitro* conditions. Students gets familiar with cell – cell adhesion properties, how cells will proliferate under *in vivo* and *in vitro* conditions, how cell differentiates in variety of other forms.

	CO3: This unit gives training to setup an animal biotechnology laboratory. An overview is explained here for the techniques to carry out primary and secondary cell lines. It also covers the various types of culture media used in culturing of animal cells in *in vitro* environment like – Defined media, Complete medium, Serum free medium etc. as well as techniques used in sterilization of media – autoclaving and filter sterilization. CO4: This unit is an introductory part of Artificial Insemination and *in vitro* fertilization (IVF) technology. Students will learn about methods used for assisted reproduction like – intra uterine sperm transfer for Artificial insemination. The unit also covers the methods used in production of multiple egg cells used in artificial insemination technologies like IVF. Also students can learn the techniques used for intra uterine embryo transfer as a part of assisted reproductive biology.
Mapping between COs with PSOs	
Pre-requisite	12th Science with Biology Subject
Course Content	**UNIT-1: Introduction to Animal Biotechnology:** 1.1 Application of animal biotechnology 1.2 Advantages and limitations of animal tissue culture 1.3 Types of tissue culture 1.4 Equipments for cell culture **UNIT-2: Biology of Cultured Cells:** 2.1 Cell adhesion 2.2 Cell proliferation 2.3 Cell differentiation **UNIT-3: Aseptic Techniques and Animal Cell Culture Media:** 3.1 Aseptic environment and sterile handling 3.2 Defined media – Physical properties of media, complete media and serum free media 3.3 Sterilization of media **UNIT-4: Animal Reproductive Biology:** 4.1 Artificial insemination 4.2 Super ovulation 4.3 *In vitro* fertilization 4.4 Embryo transfer technology
Reference Books	1. Freshney RI. Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons; 2015 Dec 23. 2. Gordon I, editor. Reproductive technologies in farm animals. CABi; 2017 Jun 23.

Teaching Methodology	Class work, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

BTP 06: Biotechnology Practical

Course Code	**BTP 06**
Course Title	Biotechnology Practical
Credit	6
Teaching per Week	12
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2020- 2021
Purpose of Course	The purpose of the course is the practical aspects of major fields like bioinformatics, plant biotechnology, animal biotechnology and microbiology. The students will become familiar with the use of a wide variety of internet applications, biological database, online tools for in silico analysis and will be able to apply these methods to basic research problems. Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems. Students can learn various bioinformatics tools for sequence retrieval or to study protein structure. They also learn the tissue culture techniques and basic microbiological techniques which may be associated with production of antibiotics and organic acids or determination of water contamination.
Course Objective	1. To provide basic knowledge of bioinformatics tools for sequence retrieval both for nucleotides and proteins followed by the alignment and sequence prediction respectively. 2. To teach the concept of primary and secondary screening of microorganisms for the production of primary and secondary metabolites. 3. To teach basic tissue culture techniques like different media preparation for in vitro establishment of various plant parts. 4. To provide basic knowledge of buffers and media and to explain its importance in culture.
Course Outcomes	CO1: The major aim is to provide them basic level training in bioinformatics methods including accessing the major public sequence databases, use of the different computational tools to find sequences, perform text and sequence based searches analysis of protein and nucleic acid sequences using various software packages. Students will learn major tools of bioinformatics which may allow them to determine the degree of homology between sequences and prove helpful in predicting putative structure of proteins. CO2: Students will develop understanding related to the industrial screening and fermentation process. They will also learn the basic techniques for detection of coliforms which are associated with water contamination. CO3: Students will get the idea related to specific media and growth condition for the development of callus from explants. CO4: Practical skills of students will be enhanced as they learn the preparation of media for culturing animal cells, sterilization techniques and isolation of specific cells.
Mapping between COs with PSOs	<table><tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td><td>PSO6</td></tr></table>

	CO1 ■ ■ ■ ■ ■ ■ CO2 ■ ■ ■ ■ ■ ■ CO3 ■ ■ ■ ■ ■ ■ CO4 ■ ■ ■ ■ ■ ■
Pre-requisite	Basic Science
Course Content	1. Nucleotide and protein Sequence retrieval from NCBI/EMBL 2. Protein Structure retrieval from Protein Data Bank (PDB) 3. Exploring information from metabolic pathway database 4. Protein structure visualization by RasMol 5. Pairwise sequence alignment using BLAST/FASTA 6. Multiple sequence alignment using Clustal Omega/Clustal X 7. Sterility testing of pharmaceutical products 8. Determine MIC of commercially available antibiotics 9. Isolation and screening of antibiotic producing microorganisms: (a) Crowded Plate Technique (b) Wilkin's Technique 10. Isolation and screening of Extracellular enzyme producing microorganisms: (a) Amylase producer (b) Protease producer (c) Cellulase producer (d) Lipase producer 11. Fermentation by eukaryotic microorganisms: (a) Aerobic- Citric acid (b) Anaerobic- Ethanol 29 12. Isolation of antibiotic resistant mutants by GPT and RPT 13. Determination of COD and BOD of given waste water 14. Detection of faecal coliforms in drinking water by defined substrate test 15. Isolation of mesophyll cell by different methods. 16. Media preparation (Murashiage and Skoog, Gamborg B5) and explants inoculation. 17. Callus culture from different explants (node, internode and leaf). 18. Preparation of buffers and media for animal cell culture: (a) PBS & HBSS (b) RPMI-1640/DMEM 19. Sterilization of buffers and animal cell culture media by autoclave and filtration techniques 20. Isolation of cells from Spleen / Liver / Chick fibroblast
Reference Books	1. Bhojwani SS, Razdan MK. Plant tissue culture: theory and practice. Elsevier; 1986 Jul 1. 2. Razdan MK. Introduction To Plant Tissue Culture, 2/E. Oxford and IBH publishing; 2002. 3. Patel RJ, Patel KR. Experimental microbiology Part II. Aditya Publication, Ahmedabad. 2016.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on

	semester end University examination

M.Sc. 7th Semester

Course: BT-1001: Bioprocess Technology-I

Course Code	**1001**
Course Title	**Bioprocess Technology-I**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The purpose of the course is to provide insights about basics of fermentation technology including concepts, methods and applications.
Course Objective	To acquaint students with the concepts of bioprocess technology.
Course Outcomes	CO1: To acquaint students with basics of sterilisation in fermentation technology. Inculcate the fundamentals of process monitoring, validation and sterility audit. Conceptualise the inoculum development and nutritional requirement at industrial scale fermentation process and provides insights about RSM technology.
	CO2: To elaborate on gas mass transfer and heat mass transfer concepts to the students. Students will gain insights on fundamentals of process control including control loops and measured elements. CO3: Students will acquire concepts of cell separation techniques. Inculcate the concepts of sample pretreatment, CGMP and regulatory considerations in bioprocess technology. Provide insights of cross-flow filtration, cell disruption techniques and centrifugation. CO4: Students will gain fundamentals of product recovery/downstream processing at the industrial scale fermentation. Students will acquire knowledge pertaining to product isolation, precipitation, chromatography, membrane separations, and electrophoresis. Also, provide illustration of product recovery trains of polysaccharides, proteins and glycolic acid at industrial scale.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■		■	■	■	■
CO2	■		■	■	■	■
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	**UNIT-1: Unit Operations in Bioprocess Technology:** 1.1 Introduction to sterilization in bioprocess industry 1.2 Equipment sterilization 1.3 Monitoring &Validation of sterilization 1.4 Sterility audit and automation 1.5 Introduction to the development of inoculums for industrial process 1.6 Nutritional requirements in fermentation processes 1.7 Introduction to Response Surface Methodology (RSM) **UNIT-2: Mass Transfer and Instrument Control:** 2.1 Gas-liquid mass transfer in cellular systems 2.2 Determination of Oxygen Transfer Rates (OTR) 2.3 Introduction to Heat Transfer 2.4 Fundamentals of Process Control 2.5 Control loops 2.6 Additional forms of Control 2.7 Measurement Elements **UNIT-3: Cell Separation Systems:** 3.1 Introduction to Cell Separation Systems. 3.2 Criteria for Decision. 3.3 Pre-treatment's. 3.4 CGMP and Regulatory Considerations. 3.5 Conventional Filtration & Cross flow Microfiltration. 3.7 Centrifugation. 3.7 Cell Disruption: Physical and Chemical Methods. **UNIT-4: Product Recovery:** 4.1 Product Isolation: Extraction and Sorption 4.2 Precipitation 4.3 Chromatography and fixed bed adsorption 4.4 Membrane Separation: RO and UF 4.5 Electrophoresis 4.6 Product Recovery Trains (General Concepts) 4.7 Recovery of: Polysaccharides, Proteins & Gluconic Acid

Reference Books	1. James, B. & Ollis David, F. (2010). Biochemical EngineeringFundamentals. Tata McGraw-Hill. 2. Lydersen, B. K., D'Elia, N. A. & Nelson, K. L. (2010). Bioprocess Engineering: Systems, Equipment and Facilities. Wiley India Pvt. Ltd. 3. Stanbury, P. F. & Whitaker, A. (1984). Principles of Fermentation Technology. Pergamon Press. 4. Vogel, H. C. & Todaro, C. M. (1996). Fermentation and biochemical engineering handbook: principles, process design and equipment. William Andrew.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment

Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based onsemester end University examination

Course: BT-1002: Enzyme Technology

Course Code	**1002**
Course Title	**Enzyme Technology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The purpose of the course is to provide the theory and knowledge relevant to the enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics.
Course Objective	Students will be introduced to the theory as well as applications of enzyme technology in food, medical, and household industries. Finally, this course serves to provide an awareness of the current and possible future applications of enzyme technologies.
Course Outcomes	CO1: To acquaint students with the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms and apply biochemical calculation for enzyme kinetics. CO2: Students will compare methods for production, purification, characterization and immobilization of enzymes that can benefit human life and plot graphs based on kinetics data. CO3: To discuss various application of enzymes that can benefit human life. CO4: Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.
Mapping between COs with PSOs	
Pre-requisite	Basic of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	**UNIT – 1: Enzyme Preparation:** 1.1 Potential Sources of Enzymes 1.2 Screening for novel Enzymes 1.3 Media for enzyme production 1.4 Extraction and large scale purification of Enzymes 1.4.1 Extraction of soluble and membrane-bound enzymes, Nature of the extraction medium 1.4.2 Preliminary and Advanced purification procedures, Criteria of purity 1.4.3 Determination of molecular weights of enzymes **UNIT – 2: Immobilized Enzymes and Biosensors:** 2.1 Preparation and properties of immobilized enzymes 2.2 Application of Immobilized enzymes: General principles 2.3 Genetic immobilization of enzymes on yeast cell surface 2.4 Biosensors: Calorimetric, Potentiometric and Optical **UNIT – 3: Large Scale/ Industrial Uses of Enzymes:** 3.1 Use of enzymes in detergents 3.2 Enzymes in the fruit juices, wine, brewing and distillation industries 3.3 Use of proteases in the leather and wool industry 3.4 Applications of glucose oxidase and catalase in the food industry 3.5 Use of enzymes in cellulose and starch hydrolysis 3.6 Use of lactases in the dairy industry 3.7 Medical applications of enzymes **UNIT – 4: Recent advances and future prospects in Enzyme Technology:** 4.1 Enzymes and recombinant DNA technology. 4.2 Synthesis of artificial enzymes- Enzyme engineering. 4.3 Use of 'unnatural' substrates. 4.4 Coenzyme-regenerating systems. 4.5 Enzymes and Bioinformatics.

Reference Books	1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry Trevor Palmer, Horwood Publishing Chichester, England. 2. Enzymes and Immobilized Cells in Biotechnology. Allen I. Laskin, The Benjamin/Cummings Publishing Company, INC., California. 3. Fermentation Microbiology and Biotechnology. Mansi El-Mansi & Charlie Bryce, Taylor & Francis Ltd, London. 4. Industrial Biotechnology. S. N. Jogdand, Himalaya Publishing House, Mumbai. 5. Fundamentals of Enzymology: Nicholes C. Price and Lewis Stevens, Oxford Univ. Press.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BT-1003: Advances in Instrumentation and Techniques

Course Code	**1003**
Course Title	**Advances in Instrumentation and Techniques**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	To impart the knowledge of advance instrument and techniques so students can utilize it in their research or dissertation work.
Course Objective	It makes student able to understand the advance instrument and their application in their future research or dissertation.
Course Outcomes	CO1: Students learn about various types of advanced spectroscopy. CO2: Students learn about various electrophoretic techniques to be used in their molecular Biology research/dissertation. CO3: Students learn about various chromatographic techniques to be used in Biotechnology research/dissertation. CO4: Student also learn about sample preparation operation and application of various instruments and techniques.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■	■	■	■	■
CO2	■	■	■	■	■	■
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	**UNIT – 1: Advances in Spectroscopy:** 1.1 Principle, Instrumentation, Interpretation of results in IR spectroscopy 1.2 FT-IR: Principle and application 1.3 Working principle of NMR 1.4 Mass spectrometry and their applications 1.5 Atomic spectroscopy 1.5.1 Atomic absorption spectroscopy: Principle, atomizers, sources and applications 1.5.2 X-ray diffraction/crystallography: Principle and application **UNIT – 2: Electrophoretic Techniques:** 2.1 Electrophoresis of proteins 2.1.1 SDS-PAGE 2.1.2 Native gels and Gradient gels 2.1.3 Isoelectric focusing 2.1.4 Two dimensional electrophoresis 2.1.5 Western blotting 2.2 Electrophoresis of nucleic acids 2.2.1 Agarose gel of DNA and RNA 2.2.2 DNA sequencing gels 2.2.3 Southern Blotting 2.2.4 PFGE, DGGE and TGGE **UNIT – 3: GC and HPTLC:** 3.1 HPTLC: Methods of development and spot detection 3.2 GC: Principle, stationary and mobile phases 3.2.1 Detectors: FID, TCD, ECD 3.2.2 Quantitative analysis and qualitative analysis 3.2.3 GC-MS combinations 3.2.4 Limitations of GC **UNIT – 4: Advances in Liquid Chromatography:** 4.1 HPLC 4.1.1 Components of Instrumentation 4.1.2 Isocratic, binary and quaternary system 4.1.3 Types of columns 4.1.4 Stationary and mobile phases 4.1.5 Detectors: UV absorption, PDA, RI and fluorescence 4.2 Ion exchange chromatography: Types of resins, principles of separation, detection and applications 4.3 Gel filtration chromatography: Principles and applications

Reference Books	1. Skoog D. Skoog and West's Fundamentals of Analytical Chemistry. Andover: Cengage Learning EMEA; 2014.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BT-1004: Cell and Tissue Culture Technology-I

Course Code	**1004**
Course Title	**BT-1004: Cell and Tissue Culture Technology-I**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The purpose of this course is to learn the details of Cell culture Technology.
Course Objective	The objective of this course is to acquaint students with Tissue culture technology utilized for plant and animal cell.
Course Outcomes	CO1: First unit deals with Plant Genomes and Plant Tissue culture where the details of eukaryotic gene systems along with the plant tissue culture techniques to be dealt. CO2: Second unit is Secondary metabolites isolation and identification. Here students would learn about the different aspects related to secondary metabolites from plants. CO3: Third unit is about Immortalization and Cell Separation Techniques. The outcome would be the knowledge of Immortalization with viral genes Telomerase-Induced immortalization, tumorigenicity and various techniques used in animal cell culture. CO4: Fourth unit is Cell culture, cryopreservation and Cell viability. Expected outcome of the unit would be the knowledge about importance of different important parameters in Cell culture technique.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	**UNIT-1: Plant Genomes and Plant Tissue Culture:** 1.1 Eukaryotic Gene structure and gene expression-regulation, Protein targeting 1.2 Types of plant promoters, enhancer and reporter system 1.3 Plant tissue culture: Culture environment and growth regulators 1.4 Types of culture **UNIT-2: Secondary Metabolites Isolation and Identification:** 2.1 Classification, Biosynthetic pathway of secondary metabolites production, factorsaffecting production of secondary metabolites in plant tissue culture 2.2 Methods of extraction and isolation 2.3 Methods of separation 2.4 Methods of identification 2.5 Applications **UNIT-3: Immortalization and Cell Separation Techniques:** 3.1 Control of senescence 3.2 Immortalization with viral genes 3.3 Telomerase-Induced immortalization 3.4 Tumorigenicity 3.5 Cell density and isopycnic sedimentation 3.6 Antibody based cell separation techniques 3.7 Fluorescence-Activated Cell Sorting (FACS) **UNIT-4: Cell culture, Cryopreservation and Cell Viability:** 4.1 Primary culture 4.2 Criteria for subculture, subculture of cells growing in suspension and in monolayer 4.3 Cryopreservation, principles of cryopreservation 4.4 Cell viability

Reference Books	1. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008. 2. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis by JB Harborne. Springer, 1998. 3. Introduction to Plant Biotechnology. 2nd edition. By H. S. Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi. 4. Plant Tissue culture: Theory and Practice, a revised Edition, S. S. Bhojwani and M.K. Razdan, Elsevier. 5. Ian R. Freshney, Culture of animal cells: a manual of basic technique and specialized applications, 6th Ed., Willey Blackwell pub.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination.

Course: BTP-1005: Enzyme and Bioprocess Technology

Course Code	**1005**
Course Title	**Enzyme and Bioprocess Technology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The purpose of the course is to provide hands on training on the enzyme and bioprocess technology.
Course Objective	To acquaint students with the practicals related to bioprocess and enzyme technology
Course Outcomes	CO1: To perform time course/temperature optima of alkaline phosphatase. CO2: To determine double reciprocal curve and enzyme inhibition kinetics of alkaline phosphatase. CO3: To determine TDP/TDT of microorganism for design of a fermenter. CO4: to estimate OTR by sulphide oxidation method and to investigate the thermal stability of the HRP enzyme. CO5……CO10: To perform immobilisation of the whole cells by calcium alginate method to carry out fermentation for production and purification of amylase and to demonstrate basic fermenter process in a bioreactor.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■		■	■	■	■
CO2	■		■	■	■	■
CO3	■	■	■		■	
CO4		■	■	■		■
CO5						■
CO6	■	■	■	■	■	■
CO7	■	■	■	■	■	■
CO8	■	■	■	■	■	■
CO9	■	■	■	■	■	■
CO10	■	■	■	■	■	■

Course Content	1. To study time, course of the reaction catalyzed by alkaline phosphatase. 2. To determine temperature optima for alkaline phosphatase. 3. To investigate the thermal stabilityof horseradish peroxidase. 4. Preparation of double reciprocal curve. 5. Study of enzyme inhibition kinetics. 6. Estimation of oxygen transfer rate (OTR) by sulphite oxidation method. 7. Immobilization of whole cells (Yeast/Bacteria) by calcium alginate method. 8. Production, estimation and purification of amylase/lipase/protease. 9. Determination of thermal death point (TDP) and thermal death time (TDT) ofmicroorganism for design of a sterilizer. 10. Demonstration of fermentation process in a bioreactor.

Reference Books	1. Pricea, N and Newman, L. (2000) Demonstration of the principles of enzyme-catalysed reactions using alkaline phosphatase. Biochemistry and Molecular Biology Education. 28; 207-210. 2. McComb R.B., Bowers G.N., Posen S. (1979) Measurement of Alkaline Phosphatase Activity. In: Alkaline Phosphatase. Springer, Boston, MA. 3. Dean, R.L. (2002), Kinetic studies with alkaline phosphatase in the presence and absence of inhibitors and divalent cations. Biochem. Mol. Biol. Educ., 30: 401-407. 4. Copeland WH, Nealon DA, Rej R. Effects of temperature on measurement of alkaline phosphatase activity. Clin Chem. 1985 Feb;31(2):185-90. PMID: 3967347. 5. Experimental Microbiology by Rakesh Patel, Volume 1 and 2
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BTP-1006: Cell Culture Technology-I

Course Code	**1006**
Course Title	**Cell Culture Technology-I**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019

<table>
<tr><td>Purpose of Course</td><td>To equip students with the practicals of Cell and tissue culture technology used in both plants and animal kingdom</td></tr>
<tr><td>Course Objective</td><td>To familiarize students on how to perform tissue culture of plants with different techniques as well as to learn the isolation of different cell types from animal system.</td></tr>
<tr><td>Course Outcomes</td><td>CO1, CO2, CO3, CO4 & CO5: This group of practical is related to Plant Tissue Culture. Outcome would be to learn how to perform tissue culture with various explants and also to isolate protoplast used in transformation studies.

CO6, CO7, CO8, CO9 & CO10: This set of experiment is related to Animal Cell Culture studies. Outcome of the practicals would be to know how to isolate Mononuclear cells from Blood, banding patterns, metaphase plate as well Cell culture maintenance.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO7</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO9</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
</table>

Course Content	**1.** Preparation of commonly used Plant Tissue culture media (MS and Gamborg's B5 media) forplantlet regeneration. **2.** Anther culture. **3.** Embryo culture. **4.** Qualitative analysis of important phytochemicals. **5.** Isolation of protoplast. **6.** To perform suspension culture (PBLC) and prepare metaphase plate. **7.** To perform GTG banding and learn Karyotyping of prepared metaphase plates. **8.** Isolation of Peripheral Blood Mononuclear Cells (PBMC). **9.** Assessment of cell viability by Trypan blue. **10.** Cell Culture: Cell revival and Cell maintenance.

Reference Books	1. Pricea, N and Newman, L. (2000) Demonstration of the principles of enzyme-catalysed reactions using alkaline phosphatase. Biochemistry and Molecular Biology Education. 28; 207-210. 2. McComb R.B., Bowers G.N., Posen S. (1979) Measurement of Alkaline Phosphatase Activity. In: Alkaline Phosphatase. Springer, Boston, MA. 3. Dean, R.L. (2002), Kinetic studies with alkaline phosphatase in the presence and absence of inhibitors and divalent cations. Biochem. Mol. Biol. Educ., 30: 401-407. 4. Copeland WH, Nealon DA, Rej R. Effects of temperature on measurement of alkaline phosphatase activity. Clin Chem. 1985 Feb;31(2):185-90. PMID: 3967347. 5. Experimental Microbiology by Rakesh Patel, Volume 1 and 2
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BT-2001: Bioprocess Technology-II

Course Code	**2001**
Course Title	**Bioprocess Technology-II**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019

<table>
<tr><td>Purpose of Course</td><td>The purpose of the course is to provide basics of fermentation of food/feed products and fine chemicals. To conceptualise industrial production in animal and plant cells and of process economics/validation</td></tr>
<tr><td>Course Objective</td><td>To acquaint students with fundamentals of large scale cultivation of microbial, animal and plant cells.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: Provide in depth understanding about fermentation of various food/feed products like wine, beer, vinegar. To provide insights about single cell proteins and gluconic acid production at industrial scale.

CO2: Provide in depth understanding about fermentation of various fine chemicals like Penicillin, citric acid, ethanol, L-Lysine and Human Recombinant insulin.

CO3: Students will gain understanding related to large scale animal cell culture and bioreactor technology. Provide insights about stirred tank characteristics, support systems and downstream processing. Also, provides fundamentals of non-traditional cell culture approaches like spin filter bioreactor, ceramic matrix and fluidised bed reactor and regulatory affairs.
Students will gain basic concepts about biopharmaceutical validation including need and occurrence, structure, resources and validation of systems and processes.

CO4: Inculcate the basics of plant cell cultivation on the large scale including the type of reactor commonly employed, difficulties in downstream processing and control parameters.

Students shall gain the concepts of nine stages of process economics in general fermentation at industrial scale. Acquire the generalise concepts of economic related o fine chemicals and bulk oxygenates and SCP production. Also, provide information regarding bioproduct regulatory bodies like FDA, USDA, OSHA etc.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
</table>

Course Content	**UNIT-1: Fermentation of Food and Feed Products:** 1.1 Fermentation of Wine 1.2 Fermentation of Beer 1.3 Fermentation of Vinegar 1.4 Production Single Cell Proteins 1.5 Fermentation of Gluconic acid **UNIT-2: Fermentation of Fine Chemicals:** 2.1 Penicillin 2.2 Citric acid 2.3 Ethanol 2.4 L-lysine 2.5 Human Recombinant Insulin **UNIT-3: Industrial Production in Animal and Plant Cells:** 3.1 Introduction to Large Scale Animal Cell Culture 3.2 Animal Cells and Bioreactor Technology 3.3 Stirred Tank Characteristics 3.4 Support Systems 3.5 Downstream Processing 3.6 Non-traditional cell culture processes & Regulatory issues 3.7 Cell culture production runs (example) & Plant cell cultivation **UNIT-4: Bioprocess Industry-Economics and Validation:** 4.1 General Fermentation Process Economics 4.2 Economics of Fine Chemicals, Bulk Oxygenates and SCP Production 4.3 Bioproduct Regulation 4.4 Introduction to Biopharmaceutical Validation 4.5 Need for Validation and Occurrence of Validation 4.6 Validation Structure and Resources for Validation 4.7 Validation of Systems and Processes

Reference Books	1. Reed G. (2004). Prescott and Dunn's Industrial microbiology. CBS Publishers & Distributors 2. Peppler, H. J., & Perlman, D. (1979). Microbial technology. Vol. 1 and 2. Academic Press Inc. 3. Vogel, H. C., & Todaro, C. M. (1996). Fermentation and Biochemical Engineering Handbook: Principles, Process Design and Equipment. William Andrew. 4. James, B., &Ollis David, F. (2010). Biochemical engineering fundamentals. Tata McGraw-Hill. 5. Lydersen, B. K., D'Elia, N. A., & Nelson, K. L. (Eds.). (2010). Bioprocess engineering: systems, equipment and facilities. Wiley India Pvt. Ltd.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BT-2002: Genomics and Proteomics

Course Code	**2002**
Course Title	**Genomics and Proteomics**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The purpose of the course is to make the student capable of implementing the knowledge related to Genes, proteins and their interdisciplinary with bioinformatics tools and to acquaint students with concepts of genomics and proteomics and its applications.
Course Objective	To make students acquainted with concepts of genomics and proteomics and its applications.
Course Outcomes	CO1: Explain students the basics of mapping using genetic and physical features of genes. To brief them about next generation sequencing tools and methods. CO2: To help students gain knowledge regarding annotation of genes, to elaborate on comparative genomics so that they can make comparisons between genomes of microbes, organelles and eukaryotes and explore the study for the application. CO3: To train students regarding different techniques used to study the basic structure of proteins, the techniques used for isolation of proteins and the platforms that are available for the identification of the proteins. CO4: To acquaint students about purification of proteins and their interactions with other proteins. To explain them about various projects related to microbial and biochemical network.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	**UNIT-1: Methods of Studying Genomes:** 1.1 Genetic mapping: DNA Markers and Linkage mapping 1.2 Physical mapping: Restriction mapping, FISH, STS mapping 1.3 Chain termination sequencing: Traditional and Alternative methodology 1.4 NGS Techniques: Template preparation, Sequencing and Imaging, EmulsionPCR 1.5 NGS Platforms: Pyro-sequencing, SOLiD, Illumina, Ion Torrent, Helicose,PacBio, Nanopore 1.6 Assembly of a contiguous DNA sequence **UNIT-2: Annotation& Functional Genomics:** 2.1 Locating genes in sequence 2.2 Determining function of individual genes 2.3 Global gene expression profiling: Microbial genes and Human diseases *2.4* Annotation case study of *Sachharomyces cerevisiae* 2.5 Comparative genomics: Bacteria, Organelles and Eukaryotes **UNIT-3: Proteomics-I:** 3.1 2-D PAGE for proteome analysis 3.2 Detection of proteins in 2D gels 3.3 Mass Spectroscopy: Introduction, background and *de novo* sequencing usingMS data 3.4 Use of protein microarrays 3.5 Structural proteomics: X-ray crystallography and NMR 3.6 International structural proteomics initiatives **UNIT-4: Proteomics-II & International Collaborative Projects:** 4.1 Methods for studying protein interactions 4.2 Use of affinity purification 4.3 Bioinformatics support to study protein interaction 4.4 Metabolomics and global biochemical networks 4.5 Human Genome Project: Mapping phase, Sequencing phase and future 4.6 Other projects: ENCODE, HapMap, Human Microbiome Project

Reference Books	1. Brown T. Genomes 3. New York and London: Garland Science; 2007. 2. Primrose S, Twyman R. Principles of genome analysis and genomics. Malden, Mass.: Blackwell Pub.; 2003. 3. Pennington, S. and Dunn M. Proteomics from protein sequence to function. New Delhi: Viva Books Private Limited; 2002.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BT-2003: Aquaculture Technology

Course Code	**2003**
Course Title	**Aquaculture Technology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The Purpose of Course is to make Students aware regarding the various aspects of Aquaculture, its history, its scopes, different systems and its applications.
Course Objective	The Objective of this paper is to give information to students regarding – How to start an Aquaculture and its various requirements. The students study about different Aquaculture systems, how to start it and how to sustain it as a profitable income source.
Course Outcomes	CO1: Explains students about the history, scope and importance of Aquaculture. CO2: Students gets the information regarding general characteristics of fishes and its economic importance. CO3: Students gets knowledge about different types of Aquaculture systems, type of Hatcheries and its designs. CO4: Explains regarding the different types of feed and its formulations, used for Aquatic animals. The course also explains the new concept involved in Aquaculture like use of Probiotics and Prebiotics. Students gets information about Marine Toxins and Biofouling which helps in overall understanding of Aquaculture. Explains various diseases affecting the fishes, its symptoms and its Diagnostic methods. Knowledge regarding new diagnostic techniques like PCR, ELISA, etc., is also included.
Mapping between COs with PSOs	
Pre-requisite	Basics of Mathematics, Data Structures

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	**UNIT-1: Introduction to Aquaculture:** 1.1. Definition, scope & significance of aquaculture 1.2. General characteristics and economic importance of fishes 1.3. Sustainable aquaculture 1.4. Fish culture process 1.5. Components, design & types of Hatcheries 1.6. Different Aquaculture Systems **UNIT-2: Aqua-Feed& Diseases:** 1.1. Importance and types of feeds 1.2. Feed formulations & feed developmental process 1.3. Prebiotics & Probiotics in Aqua-feed 1.4. Bacterial, Viral, Fungal diseases of fishes and their diagnosis 1.5. Fish spoilage & marine toxins 1.6. Bio-fouling **UNIT-3: Aquaculture Biotechnology:** 1.1. Transgenic fish production 1.2. Chromosomal manipulation – Triploidy, Polyploidy, Androgenesis & Gynogenesis 1.3. Applications of recombinant hormone & growth factors in aquaculture 1.4. Fish vaccines and its development 1.5. Cryopreservation **UNIT-4: Algal Biotechnology:** 1.1. Economic importance of seaweeds& algae 1.2. Seaweed & microalgae culture methods 1.3. Bioactive compounds from marine organisms 1.4. Molecular farming of microalgae 1.5. Enhancement of protein production by microalgae

Reference Books	1. General & Applied Ichthyology (Fish & Fisheries) by S. K. Gupta & P. C. Gupta, S. Chand Publication, New Delhi. 2. Aquaculture Technology & environment by Ujwala Jadhav, Prentice Hall of India Pvt. Ltd., New Delhi. 3. Biotechnology & Genetics in Fisheries & Aquaculture by Andy Beaumont, Pierre Boudry, Kathrin Hoare. 4. Aquaculture - Farming aquatic animals & plants – Edited by John S. Lucas, Paul C. Southgate, Blackwell publishing Company. 5. Fisheries & Aquaculture Biotechnology by Varun Mehta, Book International Pub. 6. A Textbook of Fish Biology & Fisheries by S. S. Khanna & H. R. Singh. 7. Fish Health & Diseases by B. R. Selvamani & R. K. Mahadevan, Campus books Int., New Delhi.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BT-2004: Agriculture Biotechnology

Course Code	**2004**
Course Title	**Agriculture Biotechnology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	June 2020
Purpose of Course	The purpose of the course is to provide concepts of plant tissue culture technologies and stress resistance crops production., molecular breeding and molecular farming in plants.
Course Objective	To make students acquainted with basics concepts of transgenic plant technologies, molecular breeding and molecular farming.
Course Outcomes	CO1: Students will gain in depth understanding of role and molecular actions of plant growth regulators in tissue culture. Acquire fundamentals of direct transformation of protoplasts and indirect transformation using Agrobacterium based vectors. CO2: Students shall gain insights into physiological and molecular responses of plant to water, salinity and temperature stress. Also, provides concepts of stress signalling pathways in plants. Students will gain in depth understating of plant interaction with plant pathogens and molecular and biochemical basis of host plant resistance. CO3: Students will learn about various strategies to develop herbicide tolerant plants and basic methods to develop pest tolerant (BT toxin) plants. CO4: Students will acquire knowledge about various molecular markers technologies like RFLP, RAPD, AFLP, SSR, STS, SCAR, CAPS, SNP and ISSR. Also, students will learn about QTL linkage mapping and MAS. Students shall gain insights into the basic fundamentals of molecular farming and will sight some examples of production of bio products using plant as bioreactors. Students shall gain the concepts of edible vaccines and plantibodies. Also, elaborate on the oleosin system- Hirudin and insulin production.
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	**UNIT-1: Tissue Culture & Transgenic Technologies:** 1.1 Role and molecular action of growth regulators in tissue culture 1.2 Direct transformation of protoplasts using PEG, electroporation, particlebombardment 1.3 *Agrobacterium* biology (Ti plasmids, Ri plasmids) 1.4 Ti plasmid based transformation **UNIT-2: Abiotic & Biotic Stress and Resistance of Crops:** 2.1 Abiotic stress: Physiological and molecular responses of plants to water stress,salinity stress, temperature stress 2.2 Stress perception and stress signaling pathways 2.3 Plant interaction with bacterial, viral and fungal pathogens, biochemical andmolecular basis of host plant resistance 2.4 Herbicide (glyphosate, phosphinothricin) and Pest (Bt toxin) resistance **UNIT-3: Molecular Breeding:** 3.1 Restriction based and PCR based markers; RFLP: methodology and applications,RAPD and AFLP: Principles, methodology and advantages, disadvantages and applications 3.2 Development of SCAR and SSR, ISSR markers 3.3 Other markers: CAPS, SNP, Comparison of different marker systems 3.4 QTL and MAS **UNIT-4: Molecular Farming & Applications:** 4.1 Definition and common perception of molecular farming 4.2 Transgenic plants as bioreactors 4.3 Relevance and advantages of plant based molecular farming 4.4 Edible vaccine; medicinally related proteins-antibodies (plantibodies), the oleosinsystem –Hirudinand Insulin production

Reference Books	1. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008. 2. Introduction to Plant Biotechnology. 2nd edition. By H. S. Chawla. Oxford & IBH publishing Co. Pvt. Ltd. New Delhi. 3. Plant Tissue culture: Theory and Practice, A revised Edition, S.S. Bhojwani and M.K. Razdan, Elsevier. 4. An Introduction to Plant Tissue Culture. 2nd Edition, by M. K. Razdan. Oxford & IBH Publishing Co. Pvt. Ltd.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment

Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BTP-2005: Genomics and Bioprocess Technology

Course Code	**2005**
Course Title	**Genomics and Bioprocess Technology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019
Purpose of Course	The purpose of the course is to make students recognize the basic principles of bioprocess technology and to understand bioprocesses for industrial applications and ways in which industrial productivity can be enhanced
Course Objective	To gain a hands-on experience in techniques used in bioprocess technology and their applications, principles involved in transport mechanisms and techniques involved in Upstream and downstream bioprocessing.
Course Outcomes	CO1: To learn the concepts of screening, optimization and maintenance of cultures and to introduce the students to the various concepts of microbial growth kinetics, fermentation and bioprocess engineering CO2: Understanding the different processes involved in bioprocess technology CO3: Integrating scientific and technological knowledge on the use of bioprocesses for industrial products on the cell and process level CO4……CO10: Developing and assessing the conditions for efficient and Sustainable design of bioprocesses
Mapping between COs with PSOs	
Pre-requisite	Basics of Biology, Biotechnology, Biochemistry, Microbiology

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■	■	■	■	
CO2	■	■	■	■	■	
CO3	■	■	■	■	■	
CO4		■	■	■	■	■
CO5	■	■	■	■	■	■
CO6	■	■	■	■	■	■
CO7	■	■	■	■	■	■
CO8	■	■		■		■
CO9	■	■		■		■
CO10	■	■		■		■

Course Content	**1.** Preparation of standard curve for estimation of antibiotic Penicillin. **2.** Preparation of standard curve for estimation of Citric acid **3.** Preparation of standard curve for estimation of Ethanol. **4.** Microbial fermentation of Penicillin 4.1. Determination of optimum pH for production of Penicillin. 4.2. Determination of optimum inoculum size for Penicillin production. **5.** Microbial fermentation of Citric acid 5.1. Determination of optimum pH for production of Citric acid. 5.2. Determination of optimum inoculum size for Citric acid production. **6.** Fermentative production of Ethanol using different substrates. **7.** Recovery of Citric acid and Ethanol from fermented broth/medium. **8.** Bioassay of antibiotic Penicillin. **9.** Soil DNA extraction by spin column method **10.** Total bacterial RNA extraction and separation by electrophoresis

Reference Books	1. Experimental Microbiology by Rakesh Patel, Volume 1 and 2 2. Lydersen, B. K., D'Elia, N. A., & Nelson, K. L. (Eds.). (2010). Bioprocess engineering: systems, equipment and facilities. Wiley India Pvt. Ltd. 3. Pricea, N and Newman, L. (2000) Demonstration of the principles of enzyme-catalysed reactions using alkaline phosphatase. Biochemistry and Molecular Biology Education. 28; 207-210 4. Vogel, H. C., & Todaro, C. M. (1996). Fermentation and Biochemical Engineering Handbook: Principles, Process Design and Equipment. William Andrew.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course: BTP-2006: Agriculture Biotechnology & Aquaculture Technology

Course Code	**2006**
Course Title	**Agriculture Biotechnology & Aquaculture Technology**
Credit	4
Teaching per Week	4 Hrs
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2018-2019

<table>
<tr><td>Purpose of Course</td><td>The purpose of the course is to provide hands on experience in the practicals related to aquaculture and agriculture technology.</td></tr>
<tr><td>Course Objective</td><td>The course objective is to provide training to the students for the basics of animal and plant tissue culture based techniques.</td></tr>
<tr><td>Course Outcomes</td><td>CO1: To study commercially important fish and fresh water algae / Seaweeds and conduct proximate analysis of fish feed including crude proteins, crude lipids, carbohydrates, fibres, moisture and ash).

CO2: To understand the basic guidelines for preparing review article.

CO3: To gain experience on preparation and standardisation of plant tissue culture media (MS/B5).

CO4: To perform the quantitative analysis of phenolic compounds and Flavonoids.

CO5: To perform anti-oxidant assays like DPPH and ABTS and anti-oxidant enzyme assays like SOD, catalase, peroxidase and ascorbate peroxidase.

CO6: To conduct in vitro screening tests for salinity and drought stress in plants and isolate DNA from plant source.</td></tr>
<tr><td>Mapping between COs with PSOs</td><td>
<table>
<tr><th></th><th>PSO1</th><th>PSO2</th><th>PSO3</th><th>PSO4</th><th>PSO5</th><th>PSO6</th></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
</table>

Course Content	**Aquaculture Technology:** 1. To study commercially important fishes of South Gujarat region (Any 10 specimen) 2. To study fresh water algae & sea weeds (Any 10 specimen) 3. Proximate analysis of fish feed (Crude Proteins, Crude Lipids, Carbohydrates, Fibers,Moisture & Ash) 4. Detection of White Spot Syndrome Virus in shrimps by PCR technique(Demonstration). 5. Review Article on any recent/emerging areas of aquaculture **(OR)** Field Visit to any one place – Processing Unit (Fish/Prawn), Culture Farm (Fish/Prawn), Fish Feed development industry, Fisheries/Aquaculture Educational/Research Institute, Seaweed/Algal Culture facility, Fish/Algal Product development industry **Agriculture Biotechnology:** 1. Standardization and preparation of commonly used Plant Tissue culture media (MS and Gamborg's B5) for *in vitro* regeneration of agriculturally important plants media. 2. Quantitative analysis of important phytochemicals. 3. Estimation of antioxidants and antioxidant enzymes - Ascorbate peroxidase,Superoxide dismutase, Catalase and Peroxidase. 4. Rapid *in vitro* screening tests for abiotic stress tolerance (drought and salinity). 5. Isolation of DNA from suitable plant source.

Reference Books	1. Dhindsa, Rajinder & PLUMB-DHINDSA, PAMELA & Thorpe, Trevor. (1981). Leaf Senescence: Correlated with Increased Levels of Membrane Permeability and Lipid Peroxidation, and Decreased Levels of Superoxide Dismutase and Catalase. Journal of Experimental Botany - J EXP BOT. 32. 93-101. 10.1093/jxb/32.1.93. 2. Senthilkumar M., Amaresan N., Sankaranarayanan A. (2021) Estimation of Catalase. In: Plant-Microbe Interactions. Springer Protocols Handbooks. Humana, New York, NY. 3. Reference: Re R, Pellegrini N, Proteggente A, Yang M, Rice-Evans C. Antioxidant activity applying an improved ABTS radical cationdecolorization assay. Free RadicBiol Med 1999;26:1231-7. 4. Blois, M.S. 1958. Antioxidant determination by the use of a stable free radical. Nat. 181: 1199-1200 5. Plant Tissue culture: Theory and Practice, A revised Edition, S.S. Bhojwani and M.K. Razdan, Elsevier. 6. Abraham Edit, Erdei Lasziv, Cabassa Cecile and Szabados Laszio. Methods for determination of proline in plants. Methods in molecular biology (Clifton, N.J.), March 2010. 7. The Fishes of India by Francis and Day

Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

M. Sc. Second Year

Course Code	**BT: 3001**
Course Title	Advances in Bioinformatics
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The purpose of the course is to make the student capable of implementing the knowledge related to drug designing, primer designing, secondary structure prediction and modelling, gene prediction and phylogenetic analysis.
Course Objective	To study introduction of structural bioinformatics, conformational analysis of proteins and nucleic acids To understand the protein structure prediction, and molecular interactions. To understand the drug stereochemistry drug design and molecular modelling in drug design.
Course Outcomes	CO1: Understand the basic concepts on macromolecular structures and their interactions with special emphasis on computational biology. CO2: Decipher the methods involved for protein structure prediction. CO3: Recognize the principles and methods of macromolecular interactions. CO4: Understand the aspects of the steps involved in homology modelling. Grasp the knowledge on the basic concepts of QSAR.
Mapping between COs with PSOs	
Pre-requisite	Basic Fundamental of Science, Computer skill

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	UNIT-1: MOLECULAR PHYLOGENY 1.1 Phenotypic & Molecular Phylogeny, Mechanism of Molecular Phylogeny 1.2 Representation of Phylogeny 1.3 Molecular Clocks 1.4 Methods of Phylogeny – UPGMA and NJ 1.5 Tools for Phylogentic analysis (PHYLIP) UNIT-2: GENE PREDICTION 2.1 Introduction to Gene Prediction (Finding of Genes, Finding of Exons, Exon to prediction of genes) 2.2 Types of Gene Prediction Programs (Splice site Prediction, Homology based gene prediction & Ab initio gene prediction) 2.3 Type of gene Prediction Methods-Laboratory based approach, Feature based approach, Homology based approach & Statistical & HMM based approach 2.4 Tools for Gene Prediction – GLIMMER, GENSCAN, ORF Finder UNIT-3: SECONDARY STRUCTURE PREDICTION & MODELLING 3.1 Methods for Secondary structure prediction: Chou Fasman, GOR 3.2 Softwares for Secondary structure prediction – GORIV, JPred4, APSSP2, CFSSP 3.3 Methods of Protein Modelling - Homology Modelling, Threading or fold recognition and Ab-initio structure prediction methods 3.4 Tools for protein structure modelling – Swiss Model 3.5 Ramachandran Plot for evaluation of predicted structure (Concept & Tool – RAMPAGE) UNIT-4: ADVANCES IN BIOINFORMATICS 4.1 Bioinformatics in Drug Designing: 4.1.1 Structural bioinformatics in drug designing 4.1.2 Application of QSAR in computer aided drug designing 4.2 Primer Designing: 4.2.1 Primer Selection, Primer Length, Melting Temperature (Tm), Specificity, Complementary Primer Sequence, G/C content, 3'end sequence 4.2.2 Designing a sequencing primer 4.2.2 Software for in silico primer designing: Primer Blast, Primer 3

Reference Books	REFERENCES: 1. Zhumur Gosh and Bibekan and Mallick "Bioinformatics: Principle and Application", Oxford University Press, 2008. 2. Simminder Kaur Thukral and OrpitaBosu, Pap/Cdr edition, "Bioinformatics: Database, Tools and Algorithms", Oxford University Press, USA, 2007. 3. S. C. Rastogi, N. Mendiratta and P. Rastogi, 2nd Edition "Bioinformatics: Concepts, Skill & Applications", CBS publisher & Distributor, 2009. 4. N. J. Chikhale and V.S. Gomase, 1st Edition, "Bioinformatics: Theory & Practices", Himalaya Publishing House Limited, 2007. 5. Lesk, A. K., "Introduction to Bioinformatics" 4th Edition, Oxford University Press, 2013. 6. Rukam S. Tomar, Manoj, V. Parakhia, Sunil V. Patel, B. A. Golakiya, "Molecular Markers and Plant Biotechnology" New India Publishing Agency, 2010.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment

Course Code	BT-3002
Course Title	Advances in Molecular Biology
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The purpose of the course is to make the student capable of implementing the knowledge related to molecular biology and to use thesame for therapeutics and health research.
Course Objective	To make students acquainted with concepts of Molecular biology andtheir applications
Course Outcomes	CO1: Explain students about the structure and function of genes. To explain them about the number of genes, their location, distribution of genes and to gain idea about mini satellites and micro satellites. CO2: To help students gain knowledge regarding advances in RNA and RNA based technology that includes RNA interference study and its mechanism, different types of RNA and splicing mechanisms. CO3: To train students about PCR based technology, different types of PCR, DNA microarray technology and their application in medicine and diagnosis. CO4: To acquaint students about protein based molecular techniquesthat can be used for peptide synthesis in vitro, use of nano-based quantum dots and their application in field of diagnostics.
Mapping between COs with PSOs	
Pre-requisite	Basics of Mathematics, Data Structures

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	UNIT-1: ADVANCES IN GENE STRUCTURE AND FUNCTIONS 1.1 Total Gene Numbers: In Bacteria and Eukaryotes 1.2 Gene number in Humans and the Y Chromosome 1.3 Distribution of genes and other sequences in genome 1.4 Introduction to Gene clusters and repeated sequences 1.5 Essential genes and study of expressed genes 1.6 Satellite and Mini-satellite DNA: In Arthropods and Mammals UNIT-2: ADVANCES IN RNA BIOLOGY 2.1 Riboswitches and noncoding RNAs 2.2 Bacterial Regulator RNAs: CRISPR-CAS system 2.3 miRNA, siRNA and piRNA 2.4 Mechanism of RNAi 2.5 Mechanism of splicing in Group I and Group II introns 2.6 Catalysis by RNase P and Viroid RNA UNIT-3: DNA BASED MOLECULAR BIOLOGY TECHNIQUES 3.1 PCR and its applications 3.2 Real-time Quantitative PCR 3.3 Southern blotting as diagnostic tool 3.4 Analysis of Repeatitive DNA Sequences 3.5 cDNA Microarrays and its medical applications 3.6 Analysis of SNPs UNIT-4: PROTEIN BASED MOLECULAR BIOLOGY TECHNIQUES 4.1 Introduction to peptide synthesis on solid-phase 4.2 Protein Microarray Technology 4.3 Epitope mapping 4.4 Recombinant Monoclonal Antibodies 4.5 Quantum dots 4.6 Overview of Antibody Phage Display

Reference Books	REFERENCES: 1. Krebs J, Goldstein E, Kilpatrick S, Lewin B. Lewin's Genes XI. Burlington, MA: Jones and Bartlett; 2014. 2. Walker J, Rapley, R. Molecular Biomethods Handbook, 2nd Ed., Humana Press; 2008.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BT-3003
Course Title	Biotechnology Entrepreneurship Development
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	To understand the concepts of Entrepreneurial traits and recollect the biotechnological approaches to project design to project appraisal and development through entrepreneurship
Course Objective	To understand the concepts of Entrepreneurial traits.
Course Outcomes	CO1: Introducing the basic concepts in Bio entrepreneurship CO2: Updating the role of business ideas Bio products. CO3: Motivating the entrepreneurial development in life science CO4: To understand the concepts of business idea to project design to project appraisal. To understand the concepts of bioethics, product planning and development through entrepreneurship.
Mapping between COs with PSOs	
Pre-requisite	Basics of Mathematics, Data Structures

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	UNIT-1: BIOTECHNOLOGY ENTREPRENEURSHIP 1.1 Introduction: Significance of the Biotechnology Entrepreneur, Integration of two distinctly different disciplines: Science & Business, Biotechnology entrepreneurship versus general entrepreneurship, Essential biotechnology versus entrepreneurial characteristics, Backgrounds of biotechnology entrepreneurs, Driving forces in decision making and learning from failure. 1.2 Fuel, Feed and Heal the world through Biotechnology Entrepreneurship: Industrial and Environmental Biotechnology, Food and Agricultural Biotechnology, Health Biotechnology. UNIT-2: FINANCE 2.1 Sources of Finance: Source of development finance, Project financing, Institutional financing to Entrepreneurs, Financial institutions, Role of consultancy organizations. 2.2 Financial Analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process. UNIT-3: MARKETING 3.1 Marketing Channels: Methods of marketing, Marketing channels, Marketing Institutions and Assistance, E-commerce: Benefits of E-commerce brand and Opportunities in India. 3.2 Setting up a Small Scale Industry: Location of an enterprise, Steps for starting a Small Industry, Incentives and Subsidies, Exploring Export Possibilities, Scheme of Assistance for Biotech Industry under existing Gujarat Biotech Policy. UNIT-4: BREAKTHROUGH-WHO MADE IT-GAME CHANGERS 4.1 Shantha Biotech: Unleashing Biotechnology in India. 4.2 Aravind Eye Hospital: Making a Dent in Global Blindness. 4.3 Centocor: Diagnostics Company on Monoclonal Antibodies. 4.4 Suguna Poultry Farm Ltd: Hard work, No compromise, No excuse. 4.5 The Surat Transformation: Urban Renewal.

Reference Books	REFERENCES: 1. Biotechnology Entrepreneurship (2014) Craig Shimasaki, Academic Press, USA. 2. Dynamics of Entrepreneurial Development and Management (2005) Vasant Desai, Himalaya Publishing House. 3. Making Breakthrough Innovation Happen: How Eleven Indians Pulled of the Impossible (2009) Porus Mushi, Harper Collins Publishers India. 4. The CII Entrepreneur Hand Book: Practical Advice for Starting a New Business (2010) Sushila Ravindranath, Westland Ltd. 5. The Game Changers: 20 extraordinary success stories of Entrepreneurs (2013) Y. Modi, R. Kumar & A. Kothari, Random House Publishers India Pvt. Ltd.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BT-3004
Course Title	Cell & Tissue Culture Technology-II
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The purpose of the course is to provide information about recent technological advancements in the area of cell and tissue culture technology
Course Objective	The objective of the course is to acquaint students about the gene expression and regulation in plants including various application of plant cell culture system. Also, to conceptualise about transgenic animals and cancer cell biology.
Course Outcomes	CO1: Students will gain understanding regarding the promoter-reporter contract in the plant cell culture and will also acquire knowledge of various bioinformatics tools for promoter identification and analysis. In-depth understanding of DNA foot printing, finger printing and gel shift analysis, ribozwitches and telomerase. CO2: Students shall gain understanding about recent techniques like Gateway technology, Activation tagging, Yeast complementation/two hybrid system, pull down assay, BiFC, tilling and eco tilling. CO3: Students shall develop basic concepts of chloroplast gene expression and chloroplast transformation. Also, get basic concepts of genome editing techniques like TALENS, Zinc finger nucleases, CRISPR/CAS9 etc. CO4: Students shall learn fundamentals of cell cytotoxicity assays and genotoxicity assays. Students shall have in-depth understanding of cell death pathways and regulation, stem cells and application, organ culture,

	histotypic culture, and transgenic animals. Students will gain basic concepts of cancer biology including oncogenes, tumor suppressor genes, immunotherapy and inhibition of cancer promoting proteins/angiogenesis.							
Mapping between COs with PSOs		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	
	CO1							
	CO2							
	CO3							
	CO4							
Pre-requisite	Basics of Science, Computer skill							

Course Content	UNIT-1: GENE EXPRESSION AND REGULATION IN PLANTS 1.1 In-silico analysis of the promoter to find out cis-acting elements, Promoterreporter construct to validate promoters in-vivo, DNA Foot Printing, Finger Printing, Gel Shift Analysis. 1.2 Inducible Expression System and Control of Transgene Expression through Inducible Promoters. 1.3 Ribozwitches, Aptamers and their Applications. 1.4 Telomerase Structure and Function. UNIT-2: APPLICATION OF PLANT CELL CULTURE SYSTEM 2.1 Plant Expression Vectors: Advantages of Conventional cloning Vs site specific recombination based cloning methods (Gateway Technology) 2.2 Functional analysis of genes: Activation tagging: A tool for plant gene discovery; Plant protein-protein interaction: Yeast Complementation, Yeast twohybrid, Pull down assay, BiFC; Tilling and eco-tilling. 2.3 Chloroplast Genes Expression, Chloroplast Transformation, 2.4 Genome editing and its applications. UNIT-3: ANIMAL CELL CULTURE TECHNOLOGY & TRANSGENIC ANIMALS 3.1 Cytotoxicity and Genotoxicity 3.2 Cell death and its regulation 3.3 Stem cells: Embryonic stem cells, adult stem cells, Induced pluripotent stem cells and regenerative therapy 3.4 Cell synchrony, organ culture, Histotypic culture 3.5 Introduction to transgenic animals; Techniques and Applications of animal Transgenesis UNIT-4: CANCER BIOLOGY 4.1 Basic properties of a cancer cell 4.2 The causes of cancer 4.3 Tumor-suppressor genes and oncogenes 4.4 Immunotherapy and Inhibition of cancer promoting proteins 4.5 Angiogenesis

Reference Books	REFERENCES: 1. Primrose S. B. and Twyman R. M. Principles of Gene Manipulation and Genomics; (7th Edition) Blackwell Publishing 2. Genomes, T. A. Brown, Oxford: Wiley-Liss; 2002 3. Old R. W. and Primrose S.B. Principles of Gene Manipulation: An Introduction to Genetic Engineering. University of California Press. 4. Gene IX by B. Lewin. Jones & Bartlett Learning, 2008. 5. Adrain Slater, Nigel Scott and Mark Flower A.Plant Biotechnology – The Genetic manipulation of Plants, Oxford University Press. 6. Ian R. Freshney, Culture of animal cells: a manual of basic technique and specialized applications, 6th Ed., Willey Blackwell pub. 7. Houdebine L.M., 2003, Animal Transgenesis and Cloning, John Wiley and Sons, Ltd. 8. Karp G., Cell and Molecular Biology: concepts and experiments, 7th Ed.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BTP-3005
Course Title	Bioinformatics & Molecular Biology
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	To provide practical knowledge to the students related to Bioinformatics software and Molecular biology.
Course Objective	To help them gain hands on and skill trainingrelated to bioinformatics tool and applicable techniques of molecular biology.
Course Outcomes	CO1: Students will able perform practicals on phylogenetic analysis using NJ Plot CO2-CO6: To perform secondary structure prediction and homology modeling, also analysis the protein by Ramachandran plot. CO7-CO10: Students will be given the hands-on trainingfor molecular biology-based techniques like DNA extraction, protein extraction. To provide them hands on training for the advanced techniques like SDS-PAGE and PCR, that have future application in medicine and therapeutics.

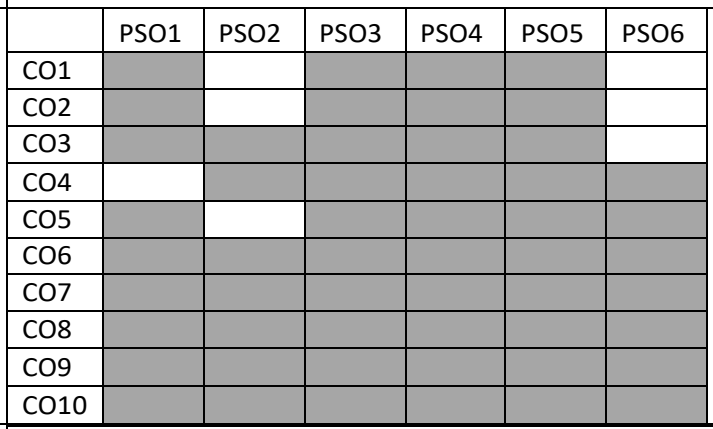
Mapping between COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						
CO5						
CO6						

	CO7							
	CO8							
	CO9							
	CO10							
Pre-requisite	Basics of Science, Computer skill							

Course Content	1. Creation of Cladogram/Phylogram using Simple Phylogeny/NJPLOT. 2. Predict ORF using ORF Finder. 3. Predict secondary structure using GORIV/JPred4. 4. Perform Homology modelling using Swiss model. 5. Perform evaluation of predicted protein by Rampage. 6. Perform Primer designing using Primer 3 / Blast Primer. 7. Separation of λ DNA digests using low-melting agarose electrophoresis, postelectrophoretic DNA elution from gel and purification by solvent /agarase enzyme method. 8. Isolation of chromosomal DNA from Saccharomyces cerevisiae / *Aspergillus niger.* 9. In vitro amplification of specific DNA fragments by Polymerase Chain Reaction. 10. SDS-PAGE separation of protein mixture, Silver/Coomassie staining of SDS-PAGE gel.

Reference Books	1. MOLECULAR CLONING: A LABORATORY MANUAL by Michael R.Green and Joseph Sambrook. 2. Himedia guidemanual for conventional Polymerase chain reaction.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BTP-3006
Course Title	Cell Culture Technology-II
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15
Effective From	
Purpose of Course	The purpose of the course is to provide hands on experience to students to the plant and animal cell culture practicals
Course Objective	The course objective is to provide training to the students for the basics of animal and plant tissue culture based techniques.
Course Outcomes	CO1: To perform direct/indirect organogenesis of agriculturally important plant/crops CO2: To conduct assay for GST/PPO/TAC for the plants CO3: To gain hands-on experience on plant RNA isolation CO4: To perform genotoxicity assay like micronucleas/DNA fragmentation assay CO5: To determine GST activity in serum CO6-CO10: To determine SOD/Catalase/LDH activity to evaluate cytotoxicity Chemicals
Mapping between COs with PSOs	
Pre-requisite	Basics of Sciences

Course Content	1. Direct organogenesis (In vitro clonal Propagation) of any plant ofagriculture/medicinal/horticultural importance. 2. Indirect organogenesis of plant of commercial importance. 3. Isolation of RNA from suitable plant source. 4. Assay of glutathione s-transferase (GST) and polyphenol oxidase(PPO). 5. Evaluation of Total antioxidant Capacity (TAC) of plants. 6. To perform Genotoxicity by Micronucleus assay and DNAfragmentation assay. 7. To perform Cytotoxicity by MTT/XTT or MTS assay. 8. Estimation of GST activity in serum/cell lysates. 9. Study of effect of cytotoxic chemicals on cells by different marker parameters (Super Oxide Dismutase and Catalase). 10. To estimate Lactate Dehydrogenase activity from cells.

Reference Books	1. EZcountTM Lactate Dehydrogenase Cell Assay Kit, CCK036, Himedia 2. Marc D. Anderson', Tottempudi K. Prasad*, and Ceci1 R. Stewart. Changes in lsozyme Profiles of Catalase, Peroxidase, and Glutathione Reductase during Acclimation to Chilling in Mesocotyls of Maize Seedlings'. Plant Physiol. (1 995) 109: 1247-1 257 3. Sylwester Sommer 1,*, Iwona Buraczewska 1 and Marcin Kruszewski. Micronucleus Assay: The State of Art, and Future Directions. International journal of Molecular sciences. 2020, 21, 1534. 4. Arul P, Shetty Smitha, Suresh Masilamani, Akshatha C. Micronucleus Assay in Exfoliated Buccal Epithelial Cells Using Liquid Based Cytology Preparations in Building Construction Workers. Iranian Journal of Pathology. 2018, 13.1. 5. Guha P, Das A, Dutta S, Chaudhuri TK. A rapid and efficient DNA extraction protocol from fresh and frozen human blood samples. J Clin Lab Anal. 2018;32:e22181.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Semester X

Course Content	BT: R-4001: Seminar Presentation: A seminar presentation will be made during the external examination by the candidates before the examiners based on the theme area or recent developments in Animal/Microbial/Plant Biotechnology. Power point presentation should be done using 25-30 slides and total time period allotted to candidate shall be 15 minutes which will include time for viva-voce. BT: R-4002: Review of Published Research Paper/Article: Oral presentation will have to be made on a selected research paper from the reputed Journal by the candidate before external examiners. List of 10 research articles shall be recommended by Board of Studies in Biotechnology every year and to be provided to all affiliated colleges running M. Sc. Biotechnology course. BT: R-4003: Poster Presentation: One poster related to research work done by the students is to be presented before external examiners. Size of the research poster prepared for external evaluation shall be 2 ft X 3 ft (portrait or landscape) and screen/digital/flex printing is allowed. Poster already prepared for participation in any seminar/conference/symposium during Semester-X can also be considered for evaluation in external examination. Student is required to produce certificate of participation as a proof that he/she has participated during Semester-X and work presented is his/her own work. BT: R-4004: Dissertation on Biotechnology (Duration for work: Minimum 3 Months) A project work should be done individually on topic related to any one of the following area justifying Animal, Microbial or Plant Biotechnology. The candidate may be allowed to work at some outside institutions as specified in rules and guidelines. Thesis will be sent for evaluation by college as per directions given by Chairman/Chairperson appointed for BT: R-4004 to external examiner for assessment. Candidate has to present his/her work in the form of presentation in external examination.

Semester X

B: Skill Based

Course Code	BT: S-4001
Course Title	ESSENTIAL SKILLS FOR BIOPHARMACEUTICAL INDUSTRY
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The course aims to impart the knowledge of theoretical aspects of Biopharmaceuticals, their production, downstream processing and product analysis.
Course Objective	To make students understand theapplications, production and analysis of the Biopharmaceuticals.
Course Outcomes	CO1: The first unit of the course covers the introduction and classes of biopharmaceuticals, use of biopharmaceuticals for gene therapy and manufacture of Biopharmaceuticals. Additionally, it also covers the aspects related to pharmacokinetic, toxicological, and drug delivery issues. CO2: The second unit of the course allow the students to understand about heproduction of the Biopharmaceuticals. Within this segment, students will be able to understand about the sources of the biopharmaceuticals as wellas upstream process methodologies involved in biopharmaceutical production. CO3: Once the upstream processes are completed, next step in biopharmaceutical production is downstream processes. Thecourse alsocovers this aspect where students will be able to understand the theoretical aspects of cell disruption, product concentration, chromatographic purifications and final product formulation, etc. CO4: The last segment of the course focuses on final product analysis which includes identification of product impurities by using different approaches. It also covers the aspects why and how the endotoxin and pyogenic contamination should be avoided in final pharmaceutical product.
Mapping between COs with PSOs	
Pre-requisite	Basics of Sciences

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■		■	■	■	■
CO2	■		■	■	■	■
CO3	■	■	■		■	
CO4		■	■	■		■

Course Content	UNIT-1: BIOPHARMACEUTICALS 1.1 Introduction and classes of biopharmaceuticals 1.2 Gene Therapy 1.3 Manufacture of Biopharmaceuticals 1.4 Pharmacokinetic, toxicological and drug delivery issues 1.5 Case Study of Biopharmaceuticals: Insulin Lispro (Humalog) and Monoclonal Antibodies UNIT-2: PRODUCTION OF BIOPHARMACEUTICALS 2.1 Sources of biopharmaceuticals 2.1.1 Escherichia coli 2.1.2 Animal cell culture systems 2.1.3 Additional systems 2.2 Upstream Processing for biopharmaceutical production: 2.2.1 Cell banking system 2.2.2 Microbial cell fermentation 2.2.3 Mammalian cell culture system UNIT-3: DOWNSTREAM PROCESSING OF BIOPHARMACEUTICALS 3.1 Cell disruption and Initial recovery 3.2 Product concentration 3.3 Chromatographic Purification 3.4 HPLC of proteins and recombinant proteins 3.5 Final product formulation UNIT-4: PRODUCT ANALYSIS 4.1 Protein based contaminants 4.2 Removal of altered forms of proteins 4.3 Detection of protein based impurities 4.4 Immunological approaches of detection 4.5 Endotoxins and other pyrogenic contaminants

Reference Books	REFERENCES: 1. Rang, H. P., Drug Discovery and development. Churchill Livingstone Elsevier, 2006. 2. Crommelin, D.J.A., Sindelar, R.D. and Meibohm. B., Pharmaceutical Biotechnology: fundamentals and applications. Informa Helthcare, 2008. 3. Walsh, G., Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, 2007. 4. Walsh, Gary, and Brendan Murphy, eds. Biopharmaceuticals, an Industrial Perspective. Springer Science & Business Media, 1999.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BT: S-4002
Course Title	ESSENTIAL SKILLS FOR BIO-SERVICES AND BIO-AGRI INDUSTRIES
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The purpose of the course is to make the student capable of implementing the knowledge related to Assisted reproductive technology and IVF.
Course Objective	To make students acquainted with concepts of IVF and the protocols related to the same.
Course Outcomes	CO1: Explain students the basics of fertilization. To explain them how to investigate couples for IVF treatment and use of fertilization basics in assisted reproduction. CO2: To help students gain knowledge regarding in vitro maturation, types of media used in embryo culture, composition of media used in embryo culture. The basics of Gamete micromanipulation. CO3: To train students regarding different techniques used to study the basics of ICSI, preparation methods for sperm retrieval and maintenance. To make them aware about the protocols for cryopreservation of sperms and eggs. CO4: To acquaint students about seed technology, to explain them different seed types, process for hybrid production, characterization of hybrids, application of CRISPR/Cas9 in crop improvement.

Mapping between COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	■	■	■	■		
CO2	■	■	■	■	■	■
CO3	■	■	■	■	■	
CO4		■	■	■		■

Pre-requisite	Basics of Sciences

Course Content	UNIT-1: INTRODUCTION OF IN VITRO FERTILIZATION 1.1 Biological basis of fertilization 1.2 Indications for IVF treatment 1.3 Initial investigation of the infertile couple 1.4 Fertilization in assisted reproduction 1.5 Role of Assistant reproduction technology nurse UNIT-2: OOCYTE AND EMBRYO HANDLING IN A. R. T. 2.1 In vitro Maturation in treatment 2.2 Outline of IVM treatment cycle 2.3 Types of media for embryo culture 2.4 Composition of embryo culture media 2.5 Gamete micromanipulation UNIT-3: SPERM PROCESSING IN A. R. T. 3.1 Sperm collection 3.2 Sperm preparation methods 3.3 Post-separation treatment of spermatozoa 3.4 Intracytoplasmic sperm injection 3.5 Protocols of cryopreservation UNIT-4: PRACTICAL SEED TECHNOLOGY 4.1 Types of seeds: Nucleus seed, Breeder seed, Foundation seed, Registered seed and certified seed 4.2 Role of male sterility in hybrid production 4.3 Assessment of genetic purity of lines and hybrids 4.4 Characterization of Lines and Hybrids for Intellectual Property Rights Protection 4.5 Recent advancement in crop improvement via genome editing:a case study for application of CRISPR- Cas9/Cpf1 in crop improvement

Reference Books	REFERENCES: 1. Gardner DK, Weissman A, Howles CM, Shoham Z, editors. Textbook of assisted reproductive techniques 5th Ed: Volume 2: Clinical perspectives. CRC press; 2018. 2. Gardner DK, editor. In vitro fertilization: a practical approach. CRC Press; 2006 Sep 29.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BT: S-4003
Course Title	ESSENTIAL SKILLS FOR CLINICAL LABORATORIES
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The purpose of the course is to provide insights about basics knowledge and skills for clinical laboratories.
Course Objective	To make student aware about various clinical methods for analysis of various samples and organisms.
Course Outcomes	CO-1-to give students basic knowledge of culture media and analysis of various samples CO-2-it will provide students insight of various marker test which make them able to differentiate between the disease. CO-3-it will give knowledge of various diagnostic methods for different disease CO-4-it helps students for cytogenetic study and automation of clinical laboratories.
Mapping between COs with PSOs	
Pre-requisite	Basics of Sciences

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

Course Content	UNIT-1: CLINICAL MICROBIOLOGY 1.1 Culture media: Composition, types and forms 1.2 Study of Escherichia, Salmonella, Leptospira andMycobacterium 1.3 Routine urine examination 1.4 Routine examination of faeces 1.5 Routine examination of semen and semen washing 1.6Routine examination of sputum UNIT-2: CLINICAL BIOCHEMISTRY 2.1 Cardiac profile tests 2.2 Kidney function tests 2.3 Liver function tests 2.4 Laboratory determination of lipids in serum 2.5 Determination of hormones 2.6 Determination of glucose and glycosylated haemoglobin UNIT-3: DIAGNOSTIC SEROLOGY 3.1 Widal test and Immunological pregnancy test 3.2 Detection of rheumatoid factor and CRP 3.3 Detection of HBsAg 3.4 Detection of Dengue Fever and Leptospira IgM 3.5 Detection of malarial parasite by strip test and microscopy 3.6 Detection of allergens and antinuclear antibodies UNIT-4: CYTOGENETICS AND AUTOMATION IN CLINICAL LABORATORIES 4.1 Cell culture, Karyotyping and FISH 4.2 Prenatal chromosomal diagnosis 4.3 Molecular diagnosis of genetic diseases 4.4 Automation in bacteriology 4.5 Discrete autoanalyzers 4.6 Introduction to working of semi-autoanalyzer

Reference Books	REFERENCES: 1. Godkar P, Godkar D. Textbook of Medical Laboratory Technology. 3rd Ed. Mumbai: Bhalani Publishing House; 2014. 2. Murray P. Manual of Clinical Microbiology. Washington, DC: ASM Press; 2011.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination

Course Code	BT: S-4004
Course Title	SKILL ENHANCEMENT LABORATORY WORK
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	The purpose of the course is to make the student capable of performing skill-based experiments related to IVF.
Course Objective	To allow students to fetch the practical knowledge and hands on training related to IVF.
Course Outcomes	CO1: To provide them hands on training related to IVF based techniques, identification of problems related to urinary tract infection and diagnosis of suspected diseases. CO2: To help students gain practical knowledge related to handling of sperms, measuring viability of sperms, their motility. CO3: To train students about use of PCR for disease diagnosis and purification of different recombinant proteins using chromatography techniques. CO4-CO9: To acquaint students about role of cryopreservation in storage of gametes. To teach them estimation of blood sugar and urea level. CO10-CO14: Students will learn applications by Demonstration method.
Mapping between COs with PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1						
CO2						
CO3						
CO4						

	CO5							
	CO6							
	CO7							
	CO8							
	CO9							
	CO10							
	CO11							
	CO12							
	CO13							
	CO14							
Pre-requisite	Basics of Sciences							

Course Content	1. Purification his-tagged recombinant proteins from bacterial hosts. 2. Detection of Endotoxins in pharmaceutical products by LAL test. 3. Routine chemical and microscopic examination of urine. 4. Microbiological diagnosis of suspected infection of Salmonella. 5. Microbiological diagnosis of Urinary Tract Infection. 6. Estimation of blood sugar by GOD method. 7. Estimation of blood urea by DAM method. 8. PCR based diagnosis of tuberculosis. 9. Identification and differentiation of Bt-cotton and Non Bt-cotton. 10. Microscopic examination of semen to study spermatozoaabnormalities (Demonstration). 11. Dilution and washing of spermatozoa (Demonstration). 12. Study of Intracytoplasmic sperm injection process (Demonstration). 13. Study of the Cryopreservation, Thawing and Vitrification of embryo(Demonstration). 14. Visit to the Assisted Reproduction Treatment (ART) centre / Clinicaldiagnostic laboratory / Seed research facility or Agriculture biotechnology research laboratory.

Reference Books	REFERENCES: 1. Experimental Microbiology volume 1 and 2 by Rakesh Patel.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment
Evaluation Method	30% Internal assessment based on class attendance, participation, class test, quiz, assignment, seminar, internal examination, etc. 70% External based on semester end University examination