M. Sc. Integrated Biotechnology VII to VIII

<table>
<tr><td>Name of Program</td><td>M. Sc. Integrated Biotechnology</td></tr>
<tr><td>Abbreviation</td><td>BT</td></tr>
<tr><td>Duration</td><td>2 Years</td></tr>
<tr><td>Eligibility Criteria</td><td>B.Sc Biotechnology/Microbiology/Biochemistry</td></tr>
<tr><td>Objective of Program</td><td>To convey scientific and technological knowledge and information with modern age orientation. To help young learners and realize that science and technology, both hand in hand can enrich and develop a personality, thus promising a life of success and achievement.</td></tr>
<tr><td>Program Outcome</td><td>PO1 Students are expected to know fundamental concepts in manipulations and applications of Plant, Animal and Microbial systems while pursuing biotechnology as degree course.

PO2 Trained students in Biotechnology principles could be used to probe biological questions or to develop technologies, devices and systems that require substantive expertise in Biology, Agriculture, Pharmaceutical, Industrial, as well as Clinical Research components.</td></tr>
<tr><td>Program Specific Outcomes</td><td>Students will be able to appear and qualify for competitive exams like NET, GSET, and GATE. They will be skilled enough to join any research institute, Biopharma industry or even start ventures of their own.

PSO1: Postgraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design, analysis, optimization and simulation of bioprocess operations.

PSO2: Students will be able to gain fundamental knowledge in animal and plant biotechnology and their applications
.
PSO3: Students will be able to (a) To elaborate concepts of biochemistry with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

PSO4: Students will be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.

PSO5: Students will be able to gain hands on experience in gene cloning, protein expression and purification.

PSO6: This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.</td></tr>
<tr><td>Mapping between POs and 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>PO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>PO2</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td></tr>
<tr><td>Medium of Instruction</td><td>English</td></tr>
<tr><td>Program Structure</td><td>Semester VII</td></tr>
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Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
1001	**Bioprocess Technology-I**	4	0	4	3 Hrs	70	30	100
1002	**Enzyme Technology**	4	0	4	3 Hrs	70	30	100
1003	**Advances in Instrumentation and Techniques**	4	0	4	3 Hrs	70	30	100
1004	**Cell and Tissue Culture Technology-I**	4	0	4	3 Hrs	70	30	100
1005	**Enzyme and Bioprocess Technology**	0	8	4	3 × 5 Hrs	70	30	100
1006	**Cell Culture Technology-I**	0	8	4	3 × 5 Hrs	70	30	100
	Total	16	16	24		420	180	600

Program Structure | Semester VIII

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
2001	**Bioprocess Technology-II**	4	0	4	3 Hrs	70	30	100
2002	**Genomics and Proteomics**	4	0	4	3 Hrs	70	30	100
2003	**Aquaculture Technology**	4	0	4	3 Hrs	70	30	100
2004	**Agriculture Biotechnology**	4	0	4	3 Hrs	70	30	100
2005	**Genomics and Bioprocess Technology**	0	8	4	3 × 5 Hrs	70	30	100
2006	**Agriculture Biotechnology & Aquaculture Technology**	0	8	4	3 × 5 Hrs	70	30	100
	Total	16	16	24		420	180	600

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.

<table>
<tr><td></td><td>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.</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>
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<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
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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 Engineering Fundamentals. 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 on semester 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

	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

<table>
<tr><td>Course Code</td><td>1003</td></tr>
<tr><td>Course Title</td><td>Advances in Instrumentation and Techniques</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</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>2018-2019</td></tr>
<tr><td>Purpose of Course</td><td>To impart the knowledge of advance instrument and techniques so students can utilize it in their research or dissertation work.</td></tr>
<tr><td>Course Objective</td><td>It makes student able to understand the advance instrument and their application in their future research or dissertation.</td></tr>
<tr><td>Course Outcomes</td><td>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.</td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
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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

<table>
<tr><td>Course Code</td><td>1004</td></tr>
<tr><td>Course Title</td><td>BT-1004: Cell and Tissue Culture Technology-I</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</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>2018-2019</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of this course is to learn the details of Cell culture Technology.</td></tr>
<tr><td>Course Objective</td><td>The objective of this course is to acquaint students with Tissue culture technology utilized for plant and animal cell.</td></tr>
<tr><td>Course Outcomes</td><td>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.</td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
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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

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<tr><td>Course Code</td><td>1005</td></tr>
<tr><td>Course Title</td><td>Enzyme and Bioprocess Technology</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</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>2018-2019</td></tr>
<tr><td>Purpose of Course</td><td>The purpose of the course is to provide hands on training on the enzyme and bioprocess technology.</td></tr>
<tr><td>Course Objective</td><td>To acquaint students with the practicals related to bioprocess and enzyme technology</td></tr>
<tr><td>Course Outcomes</td><td>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.</td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
</table>

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 stability of 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>
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<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>
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</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

<table>
<tr><td>Course Code</td><td>2002</td></tr>
<tr><td>Course Title</td><td>Genomics and Proteomics</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</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>2018-2019</td></tr>
<tr><td>Purpose of Course</td><td>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.</td></tr>
<tr><td>Course Objective</td><td>To make students acquainted with concepts of genomics and proteomics and its applications.</td></tr>
<tr><td>Course Outcomes</td><td>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.</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>
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<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>
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</td></tr>
<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
</table>

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

<table>
<tr><td>Course Code</td><td>2003</td></tr>
<tr><td>Course Title</td><td>Aquaculture Technology</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</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>2018-2019</td></tr>
<tr><td>Purpose of Course</td><td>The Purpose of Course is to make Students aware regarding the various aspects of Aquaculture, its history, its scopes, different systems and its applications.</td></tr>
<tr><td>Course Objective</td><td>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.</td></tr>
<tr><td>Course Outcomes</td><td>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.</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>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Pre-requisite</td><td>Basics of Mathematics, Data Structures</td></tr>
</table>

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

<table>
<tr><td>Course Code</td><td>2004</td></tr>
<tr><td>Course Title</td><td>Agriculture Biotechnology</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hrs</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>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.</td></tr>
<tr><td>Course Objective</td><td>To make students acquainted with basics concepts of transgenic plant technologies, molecular breeding and molecular farming.</td></tr>
<tr><td>Course Outcomes</td><td>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.</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>
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<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>Pre-requisite</td><td>Basics of Biology, Biotechnology, Biochemistry, Microbiology</td></tr>
</table>

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>
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<tr><td>CO6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</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

Name of Program	M. Sc. Integrated Biotechnology
Abbreviation	BT
Duration	2 Years
Eligibility Criteria	B. Sc. In Biotechnology/Microbiology/Biochemistry
Objective of Program	To convey scientific and technological knowledge and information with modern age orientation. To help young learners and realize that science and technology, both hand in hand can enrich and develop a personality, thus promising a life of success and achievement.
Program Outcome	PO1 Students are expected to know fundamental concepts in manipulations and applications of Plant, Animal and Microbial systems while pursuing biotechnology as degree course. PO2 Trained students in Biotechnology principles could be used to probe biological questions or to develop technologies, devices and systems that require substantive expertise in Biology, Agriculture, Pharmaceutical, Industrial, as well as Clinical Research components.
Program Specific Outcomes	Students will be able to appear and qualify for competitive exams like NET, GSET, and GATE. They will be skilled enough to join any research institute, Biopharma industry or even start ventures of their own. PSO1: Postgraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design, analysis, optimization and simulation of bioprocess operations. PSO2: Students will be able to gain fundamental knowledge in animal and plant biotechnology and their applications . PSO3: Students will be able to (a) To elaborate concepts of biochemistry with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry. PSO4: Students will be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases. PSO5: Students will be able to gain hands on experience in gene cloning, protein expression and purification.

	PSO6: This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.
Mapping between POs and PSOs	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
PO1						
PO2						

Medium of Instruction	English
Program Structure	Semester IX

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration (Hours)	Marks		
BT: 3001	Advances in Bioinformatics	4	0	4	3	70	30	100
BT: 3002	Advances in Molecular Biology	4	0	4	3	70	30	100
BT: 3003	Biotechnology Entrepreneurship Development	4	0	4	3	70	30	100
BT: 3004	Cell and Tissue Culture Technology-II	4	0	4	3	70	30	100
	Practical							
BTP: 3005	Bioinformatics and Molecular Biology	0	8	4	3x5	70	30	100
BTP: 3006	Cell Culture Technology-II	0	8	4	3x5	70	30	100
	Total	16	16	24		420	180	600

Program Structure	Semester X A: Research Based

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration (Hours)	Marks		
BT: R-4001	Seminar Presentation	0	0	4	*	70	30	100
BT: R-4002	Review of Published Research Paper/Article	0	0	4	*	70	30	100
BT: R-4003	Poster Presentation	0	0	4	*	70	30	100
BT: R-4004	Dissertation on Biotechnology	0	18	12	*	200	100	300
* 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.								
	Total	0	18	24		410	190	600

Program Structure	Semester X B: Skill Based

Course Code	Title	Teaching per week		Course Credits	University Examination		Internal Marks	Total Marks
		Theory	Practical		Duration	Marks		
BT: S-4001	**Essential Skills for Biopharmaceutical Industry**	4	0	4	3	70	30	100
BT: S-4002	**Essential Skills for Bio-services and Bio-Agri Industries**	4	0	4	3	70	30	100
BT: S-4003	**Essential Skills for Clinical Laboratories**	4	0	4	3	70	30	100
BT: S-4004	**Skill Enhancement Laboratory Work**	0	18	12	3x5	200	100	300
	Total	12	18	24		410	190	600

M. Sc. Biotechnology 1st Semester

<table>
<tr><td>Course Code</td><td>BT: 3001</td></tr>
<tr><td>Course Title</td><td>Advances in Bioinformatics</td></tr>
<tr><td>Credit</td><td>4</td></tr>
<tr><td>Teaching per Week</td><td>4 Hours/week</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>2019</td></tr>
<tr><td>Purpose of Course</td><td>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.</td></tr>
<tr><td>Course Objective</td><td>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.</td></tr>
<tr><td>Course Outcomes</td><td>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.</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>
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</td></tr>
<tr><td>Pre-requisite</td><td>Basic Fundamental of Science, Computer skill</td></tr>
</table>

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,

<table>
<tr><td></td><td>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.</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 Science, Computer skill</td></tr>
</table>

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 two hybrid, 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

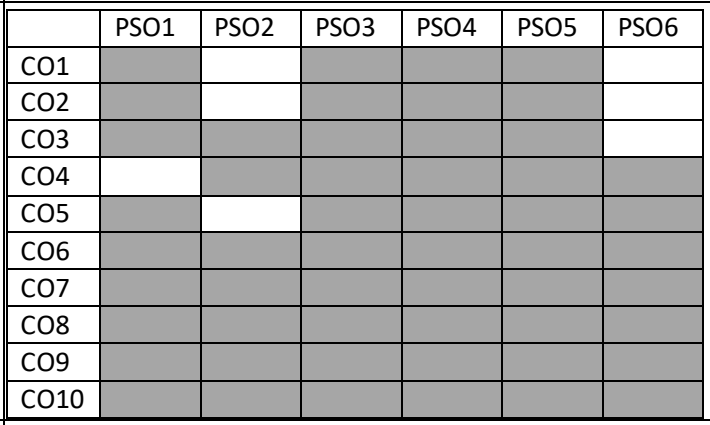
Course Code	BTP-3005
Course Title	Bioinformatics & Molecular Biology
Credit	4
Teaching per Week	4 Hours/week
Minimum weeks per Semester	15 (Including Classwork, examination, preparation, holidays etc.)
Effective From	2019
Purpose of Course	To provide practical knowledge to the students related to Bioinformatics software and Molecular biology.
Course Objective	To help them gain hands on and skill training related 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 training for 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 guide manual 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

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

Course Content	1. Direct organogenesis (In vitro clonal Propagation) of any plant of agriculture/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 DNA fragmentation 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 the applications, 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. The course 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 and Mycobacterium 1.3 Routine urine examination 1.4 Routine examination of faeces 1.5 Routine examination of semen and semen washing 1.6 Routine 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 spermatozoa abnormalities (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 / Clinical diagnostic laboratory / Seed research facility or Agriculture biotechnology research laboratory.

Reference Books	Experimental Microbiology volume 1 and 2 by Rakesh Patel.
Teaching Methodology	Classwork, Discussion, Self-Study, Seminars and/or Assignment