School Of Biotechnology

Detailed Course Curriculum

M.Sc. Biotechnology 2023-2024 onwards

Shri Mata Vaishno Devi University
Kakryal, Katra 182320 Jammu & Kashmir

VISION STATEMENT OF SMVDU

Establishment of a Scientific & Technical University of Excellence to nurture young and talented human resources for the service of Indian Society & world at large and preserving the integrity and sanctity of human values.

MISSION STATEMENT OF SMVDU

The mission of the University is the pursuit of Education, Scholarship and Research at the highest International level of excellence.

OBJECTIVES

- Provide education and training of excellent quality, both at undergraduate and postgraduate level.
- Ensure that the University achieves and maintains an international standing in both teaching and research
- Promote study and research in new and emerging areas and encourage academic interaction of the faculty and the students at national and international levels.
- Encourage close collaboration with industry and facilitate the application of research for commercial use and for the benefit of society.

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Website: www.smvdu.ac.in

School of Biotechnology

Vision:

- To bring in quality of life through developing and imparting knowledge in the field of life-sciences and embracive technologies.

Mission:

- To be a platform for research and education in the field of biotechnology at par with international standards.
- To develop a research aptitude amongst stakeholders with an aptitude to serve the local and international issues in the field of life sciences.

Objectives:

- To provide impetus to the activity of knowledge acquisition and education of students in basic sciences and technological know-how associated with the field of biotechnology, and other relevant areas.
- To focus our teaching and research activities strategically around national economic goals.
- To facilitate comprehensive learning, combining the scientific, technological and social aspects.
- To seek new models of collaboration with other institutes, universities and industries.
- To combine academics and the thrill of innovation.

M.Sc Biotechnology

Programme Outcomes

A Degree Program should be designed to prepare professionals who can fulfil the expectations of Industry / Market. Expectations of Market / Industry from a fresh graduate are known as Graduate Attributes (GAs), which are translated in the terms of Program Outcomes (POs) in general or Program Specific Outcomes **(PSOs)** for specific programs. For Every degree Programme broad expectations from a graduating student should be listed by the school.

Program Outcomes (Pos)

PO 1. Scientific Knowledge:

Apply interdisciplinary approach for understanding insights of biological systems.

PO 2. Modern Tool Usage:

Learn and implement the traditional and recent biotechnological tools for addressing biological phenomena.

PO 3. Conduct Investigations of Complex Problems:

Identify research problems, use acquired knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 4. Design/ Development of Solutions:

Trained in appropriate biotechnological techniques and resources, with an understanding of their limitations, finding innovative solutions, including design of experiments and interpretation of data.

PO 5. Science, Ethics and Society:

Capability to apply acquired knowledge in the context of societal, health, safety, legal, ethical and cultural issues with special reference to J&K State and humanity at large.

PO 6. Environment and Sustainability:

Understand the impact of scientific solutions in environmental contexts for sustainable development

PO 7. Individual and Team Work:

Function effectively as an individual, member in diverse teams with motivation and potential to develop start-ups.

PO 8. Life-long learning:

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO 1: To empower the students to apply practical skills, knowledge of basic and applied sciences & technology in biological sciences.

PSO 2: To enable the student to take-up career in academics, industries and advanced research in biotechnology with high regard to ethical values, environmental and social issues.

M. Sc. (Biotechnology) Program Structure

Semester I

Sr. No	Course Category	Course Code	Course Title	L	T	P	Credits
1	Core Course	BTL 6021	Cell & Molecular Biology-I	3	1	0	4
2	Core Course	BTL 6043	Fundamentals of Biochemistry	3	1	0	4
3	Core Course	BTL 6072	Fundamentals of Microbiology	3	1	0	4
4	Core Course	BTL 6173	Analytical Approaches in Biotechnology	3	0	0	3
5	Core Course	BTL 6161	Biostatistics	2	0	0	2
6	Open Elective - I	CSL 6011/BUE 6011	Basics of Computers & IT/Entrepreneurship Management	3	0	0	3
7	Core Course	BTP 6046	Fundamentals of Biochemistry lab	0	0	3	1.5
8	Core Course	BTP 6075	Fundamentals of Microbiology lab	0	0	3	1.5
			Total Credits	**17**	**3**	**6**	**23**

Semester II

Sr.No	Course Category	Course Code	Course Title	L-T-P	T	P	Credits
1	Core Course	BTL 6022	Cell & Molecular Biology -II	3	0	0	3
2	Core Course	BTL 6201	Plant Cell Culture	2	0	0	2
3	Core Course	BTL 6191	Animal Cell Culture	2	0	0	2
4	Core Course	BTL 6182	Principles of Immunology	3	0	0	3
5	Core Course	BTL 7152	Genetic Engineering and Applications	3	0	0	3
6	Core Course	BTL 6091	Molecular Genetics	3	1	0	4
7	Core Course	BTP 6023	Cell & Molecular Biology -II lab	0	0	3	1.5
8	Core Course	BTP 6176	Cell Culture lab	0	0	3	1.5
9	Core Course	BTP 6185	Principles of Immunology Lab	0	0	3	1.5
10	Core Course	BTP 7155	Genetic Engineering and Applications Lab	0	0	3	1.5
			Total Credits	**16**	**1**	**12**	**23**

Note: *Practical Training* to be performed in the summer vacation following the second semester for 50 days

Semester III

Sr. no	Course Category	Course Code	Course Title	L	T	P	Credits
1	Core Course	BTL 7222	Computational Biology & Bioinformatics	3	0	0	3
2	Core Course	BTL 6272	Applied Enzyme Catalysis	3	0	0	3
3	Core Course	BTL 7234	Bioprocess Engineering and Technology	3	1	0	4
4	Elective-I	BTE XXXX	School Elective - I (4 choices)	3	0	0	3
5	Elective-II	BTE XXXX	School Elective - II (4 choices)	3	0	0	3
6	Summer Training	BTC 7211	Colloquium	---	-	-	1.5
7	Core Course	BTP 7225	Computational Biology & Bioinformatics Lab	0	0	3	1.5
8	Core Course	BTP 6275	Applied Enzyme Catalysis Lab	0	0	3	1.5
9	Core Course	BTP 7237	Bioprocess Engineering and Technology Lab	0	0	3	1.5
10	Open Elective - II	PCL 7067	Discourse on Human Virtues (Open Elective - II)	3	0	0	3
			Total Credits	**18**	**1**	**19**	**25**

Semester IV

Sr. no	Course Category	Course Code	Course Title	L	T	P	Credits
1	Project work	BTD 7012	Dissertation & Viva Voce	-	-	-	20
							20
			Total Credits				**91**

List of School Electives (M. Sc.) (Biotechnology)

For School Elective - I
BTE 7292 Food Science & Technology
BTE 7081 Microbial Biotechnology
BTE 7413 Principles of Intellectual Property Rights & Biosafety
BTE 7352 Stem Cell Biology and Applications
For School Elective - II
BTE 7211 Applications of Plant Biotechnology
BTE 7341 Radiation Biology
BTE 7332 Genome stability Regulation and Drug Development
BTE 7402 Drug Delivery and Pharmacokinetics

Detailed Course Contents

Course Code : **BTL 6021**
Course Title : **Cell & Molecular Biology-I**
L-T-P/S=Credits : **3-1-0 =4**
Course Category : **Core Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Unit I: Cell Membrane and Intracellular Organelles.** Plasma membrane: Study of Structure and function through various proposed models. Regulation of intracellular transport. Structural organization and function of intracellular organelles.	11
2	**Unit II: Genetic Material and Genome Replication.** Historical development of molecular biology. DNA and RNA as genetic materials, Nucleic Acid- structure, forms and function, Replication mechanism, enzymes in replication, regulation of genome replication. Topology of nucleic acids.	11
3	**Unit III: DNA Damage and Repair.** Mutations, molecular mechanisms of mutagenesis, DNA repair systems	10
4	**Unit IV: Genome Organization. Genome organization in eukaryotes**- chromatin structure and function, genome packaging, chloroplast and mitochondrial genomes.	10
5	**Unit V: Protein Synthesis.** Transcription and translation, ribosome structure and function. Genetic code –nature and deciphering; Regulation of prokaryotic gene expression	10

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Molecular Biology of the Cell, Alberts B, Johnson A, Lewis J, Raff M, Roberts K & Walter P, 4th Edition, New York & London, Garland Science.	2002
2	CellBiology (Eds. De Robertis EDP, Francisco AS & De Robertis EMF) 6th Edition, WB Saunders Co Ltd.	2005
3	Molecular Biology of the Gene, James W Richard, Michael, Alexander G, Tania B, & Stephen B, 5th Edition, Benjamin-Cummings Publishing Company.	2003
Reference Books		
1	Molecular Cell Biology, Harvey L, Arnold B, Chris AK, Monty K, Matthew PS, Anthony B& Paul M, 8th Edition, WH Freeman & Co Ltd.	2016
2	Cytology Genetics and Evolution, Gupta PK, Rastogi Publications	2005

Course Outcome

Sr	Course Outcome	CO
1	Discuss the most significant discoveries and theories through the historical progress of biological scientific discoveries, and their impacts on the development of molecular biology.	CO1
2	Give an account of the structure and functions of the plasma membrane and the major organelles that occur in a cell.	CO2
3	Explainthefundamentalstructure,propertiesandprocessesinwhichnucleicacidsplaya part.	CO3
4	Associate the processes that unfold in individual cell compartments as preconditions for the functioning of the cell as a whole including various levels of genome organization, generegulation and protein function	CO4
5	Exhibitaknowledgebaseincellandmolecularbiology.	CO5
6	Usegeneraltexts, referencebooks anda rangeof other resources tofurther develop knowledge of biological issues through continued independent learning	CO6

Course Code : **BTL 6043**
Course Title : **Fundamentals of Biochemistry**
L-T-P/S=Credits : **3-1-0 = 4**
Course Category : **Core course**
Pre-requisite Courses (if any) : **NA**
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Carbohydrates and Lipids:** Classification of carbohydrates, structures of mono, oilgo and polysaccharides, properties and functions of carbohydrates; Classification of lipids, structures, properties and functions of lipids.	13
2	**Proteins & Amino acids**: Classification of amino acids, chemical reactions and physical properties of amino acids, Proteins Classification, criteria of homogeneity, conformation of protein; primary, secondary, tertiary and quaternary structure, Disulphide bridges, Ramachandran plot; Protein folding, Protein stability.	13
3	**Enzymes and Nucleic Acids:** Nucleic Acids - structures of purines, pyrimidines, nucleosides and nucleotides. Stability and formation of phosphodiester bonds, Denaturation and renaturation of DNA-Melting Curves. Enzymes-Classification, mechanism of action and Kinetics.	13
4	**Principles of Bioenergetics:** Study of metabolite pathways such as glycolysis, citric acid cycle, pentose phosphate pathway, gluconeogenesis, Electron transport and oxidative phosphorylation Biosynthesis of Carbohydrate, β-oxidation of Fatty acids, biosynthesis of Lipid; metabolism of amino-acids and related molecules**.**	13

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Lehninger: Principles of Biochemistry, 7th edition by David L. Nelson and M.M. Cox; W. H. Freeman and Company.	2017
2	Fundamentals of Biochemistry: Life at the Molecular Level, 5th Edition by Donald Voet, Judith G Voet and Charlotte W. Pratt; Wiley.	2016
3	Biochemistry, 6th edition by R.H. Garrett and C.M. Grisham; Brooks/Cole Cengage Learning.	2010

Course Outcome

Sr	Course Outcome	CO
1	Learn principles that govern the structures of macromolecules and their participation in living cells.	CO1
2	Demonstrate advanced knowledge and understanding of aspects of physical, chemical and biological properties of biomolecules.	CO2
3	Understand concepts of free energy & different types of chemical bonding, biocatalysts and molecular machinery of living cells.	CO3
4	Understand the various metabolic processes and how energy produced as well as utilized for various biological functions.	CO4

Course Code : **BTP 6046**
Course Title : **Fundamentals of Biochemistry Lab**
L-T-P/S=Credits : **0-0-3 = 1.5**
Course Category : **Core course**
Pre-requisite Courses (if any) : **NA**
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

List of Experiments

Sr	Contents
1	**Preparation of Buffers**
2	**Qualitative test of carbohydrates**
3	**Colorimetric and spectrophotometry** Protein estimation by Lowry's method Protein estimation by Bradford method Estimation of sugars by Anthrone method
4	**Analysis of fats/oils** Determination of acid value of a fat Determination of saponification value of a fat Determination of Iodine number of a fat
5	**Chromatographic Techniques** Identification of sugars by paper chromatography Separation of lipids by thin layer chromatography Separation of amino acids by thin layer chromatography
6	**Electrophoresis Techniques** Native polyacrylamide Gel Electrophoresis SDS polyacrylamide Gel Electrophoresis

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Introductory Practical Biochemistry by S.K. Sawhney and Co.	2001
2	Manual for Practical Biochemistry by Indu Bhushan and Co.	2023
3	Harper's Illustrated Biochemistry, 30th Edition, Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell.	2015

Course Outcome

Sr	Course Outcome	CO
1	Apply appropriate biotechnological techniques, Identify research problems, design of experiments, analysis and interpretation of data.	C05

Course Code : **BTL 6072**
Course Title : **Fundamentals of Microbiology**
L-T-P/S=Credits : **3-1-0 =4**
Course Category : **Departmental Core Course**
Pre-requisite Courses (if any) : **Nil**
Equal Course Code (if any) : **Nil**
Equivalent Course Code (if any) : **Nil**

Detailed Syllabus

Sr	Contents	Approx. ContactHours
1	**Introduction to Microbiology:** General characters of microbes – Historical developments in microbial biotechnology, the concept of microbial origin of fermentation, Microscopy Techniques; Structure and general characteristics of Bacteria, Archaea, Fungi and Algae; Identification methods of bacteria and other microorganisms, Fundamentals of classification of bacteria, fungi and algae. Recent trends in microbial taxonomy.	10
2	**Introduction to Viruses: Ultstructure , classification and replication mechanism in** viruses and phages. Importance of viruses in biotechnology with reference to -Retroviruses, TMV, HIV, SV40, Prions-Kuru. Methods of cultivation of viruses	5
3	**Microbial Nutrition, Growth, and Control:** Microbial nutrition and growth - Nutrition in microorganisms and assimilation of nutrients, Nutritional groups of microorganisms and their importance in fermentation industry, Culturing of microorganisms in laboratory and industry, Microbial media and their application, Microbial growth and growth curve, influence of environmental factors on growth. Growth measurement techniques. Concept of pure culture and methods of pure culture development. Methods of preservations of microbial cultures of industrial applications; Concept of sterilization, Methods of sterilization and their application in industry.	18
4	**Microbial Metabolism and Microbial Pathogenicity:** Energy transduction in microbial systems. Aerobic and anaerobic pathways. Sulfate reduction, Nitrogen metabolism - nitrate reduction, nitrifying and denitrifying bacteria, Nitrogen fixation and Microbes used as biofertilizer. Role of microbial biota in natural environment. Microbial ecology; Microbial pathogenicity.	19

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Prescott's Microbiology, 12th Edition, Willey J, Sherwood L & Woolverton CJ, Mc-Graw-Hill	2022
2	Microbiology: An Introduction, 12th Edition, Tortora GJ, Funke BR, Case CL, Pearson.	2016
3	Microbiology, 5th Edition, Pelczar Jr., McGraw Hill Education.	2022
Reference Books		
1	Brock Biology of Microorganisms, 15th edition, Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley and David A. Stahl, Pearson	2018

Course Outcome

Sr	Course Outcome	CO
1	Understand the basic principles of microbiology.	CO1
2	Acquire the knowledge of microbial cell structure, growth and Nutrition.	CO2
3	Understand the diversity, Metabolism and pathogenicity of microorganisms	CO3
4	Describe the applied aspects of microbiology.	CO4

Course Code : **BTP 6075**
Course Title : **Fundamentals of Microbiology Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Departmental Core Course**
Pre-requisite Courses (if any) : **Nil**
Equal Course Code (if any) : **Nil**
Equivalent Course Code (if any) : **Nil**

List of Experiments

Sr	Contents
1	Preparation of culture media, glassware and sterilization
2	Isolation and purification of microorganisms from soil/water/air by streak plate method and serial dilution
3	To understand the construction and working of Light Microscopy -Principle, variousparts,uses and care.
4	To determine Size measurement of the purified bacterial strain
5	To perform Gram staining of the purified bacterial culture
6	To perform the negative staining of the purified bacterial culture
7	To perform acid fast staining
8	To performs pore staining by the Schaeffer Fulton method
9	To perform capsule staining to distinguish between capsular material and bacterial cell
10	To test for the antibiotic sensitivity of the bacterial sample
11	To perform the MIC test for antibiotic sensitivity of a bacterial strain against as pecificantibiotic
12	To perform IMVIC test for coliformbacteria
13	To study themotility of bacterial strain using the hanging drop technique
14	To perform standard growth curve of purified bacterial strain
15	Preservation of microbial strain.

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Microbiology: A Laboratory Manual, 11th Edition, Cappuccino JG & Sherman N, Pearson Publishers.	2017
2	Alcamo'sLaboratory Fundamentals of Microbiology, 10th Edition, Pommerville JC, Jones and Bartlett Publishers.	2013
3	Experiments in Microbiology,Plant Pathology and Biotechnology, 5th Edition, Aneja KR, New Age International Publishers.	2017
Reference Books		
1	Laboratory Manual of Microbiology and Biotechnology, 2nd Edition, Aneja KR	2018
2	Microbiology: A Laboratory Manual, 10th Edition, Cappuccino JG & Sherman N, Pearson Publishers.	2013

Course Outcome

Sr	Course Outcome	CO
1	Isolate Microorganisms inside the lab and to handle them aseptically	CO1
2	Observe the basic characteristics of bacteria with the help staining techniques and microscopy	CO2
3	Understand and demonstrate the antibiotic sensitivity and MIC of a given bacterial culture	CO3
4	Perform growth curve experiment and preservation techniques of microbial cultures	CO4

Course Code : **BTL 6173**
Course Title : **Analytical Approaches in Biotechnology**
L-T-P/S=Credits : **3-0-0 =3**
Course Category : **Science Course**
Pre-requisite Courses (if any) :
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Electrophoresis and Viscosity:** Electrophoretic techniques Principles of electrophoretic separation. Continuous, zonal andcapillary electrophoresis, different types of electrophoresis including paper, cellulose,acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis. Viscosity: Viscosity ofmacromolecules, relationship with conformational changes.	10
2	**Spectroscopic Techniques:** Spectroscopy Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry.Beer-Lamberts law, Principles and applications of colorimetry; ORD, CD, X-ray diffraction, X-ray absorption, NMR.	10
3	**Chromatography and Centrifugation:** Chromatography Principles of partition chromatography, paper, thin layer, ion exchange andaffinity chromatography, gel permeation chromatography, HPLC and FPLC. Centrifugation:Principles of centrifugation, concepts of RCF, different types of instruments and rotors,preparative, differential and density gradient centrifugation, analytical ultra-centrifugation,determination of molecular weights and other applications, subcellular fractionation.	10
4	**Electron Microscopy and Radioactivity:** Electron microscopy, Transmission and scanning, freeze-fracture techniques, specific staining ofbiological materials. Basics of radioactivityand autoradiography, Safety aspects of radiation, Biosensors.	9

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Physical Biochemistry: Applications to Biochemistry and Molecular Biology, Freifelder D, W. H. Freeman.	1983
2	Analytical Biotechnology (Methods and Tools in Biosciences and Medicine), Thomas G.M.Schalkhammer, Springer	2002
3	Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, Cambridge University Press	2013

Course Outcome

Sr	Course Outcome	CO
1	Describe the principles of electrophoretic techniques and their applications.	CO1
2	Understand the principles of spectroscopic techniques and their applications.	CO2
3	Explain the principles of chromatography techniques and their applications.	CO3
4	Describe the principles of centrifugation techniques and their applications.	CO4
5	Describe the principles of electron microscopy, radioactivity, biosensor, viscosity and appreciate their uses.	CO5

Course Code : **BTL 6161**
Course Title : **Biostatistics**
L-T-P/S=Credits : **2-0-0 =2**
Course Category : **Core Course**
Pre-requisite Courses (if any): NA
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	Basic terms, measures of central tendency and dispersion: Population, sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation.**[**	6
2	Probability and distributions: Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples bernoulli, binomial, poisson and normal distributions.	6
3	Methods of sampling: Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.	8
4	Hypothesis testing: Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Introduction to analysis of variance.	6

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Methods in Biostatistics: For Medical Students and Research Workers, 9th Edition, Mahajan BK, JAYPEE.	2018
2	Understanding Biostatistics, Kallen A, Wiley	2011
3	Fundamentals of Biostatistics 7th Edition, Rosner B, Brooks/Cole Cengage Learning.	2010

Course Outcome

Sr	Course Outcome	CO
1	Learn data collection, organization, summarization and analysis.	CO1
2	Demonstrate skills in drawing inferences about a body of data when only a part of the data is observed.	CO2
3	Demonstrate skills in interpreting and communicating the results of statistical analysis, orally and in writing.	CO3
4	Apply basic statistical concepts commonly used in Health and Medical Sciences.	CO4

Semester-II

Course Code : BTL 6022
Course Title : Cell and Molecular Biology-II
L-T-P/S=Credits : 3-0-0 =3
Course Category : Departmental Core Course
Pre-requisite Courses (if any) : Nil
Equal Course Code (if any) : Nil
Equivalent Course Code (if any) : Nil

Detailed Syllabus

Sr	Contents	Approx. ContactHours
1	**Regulation of Gene expression in eukaryotes:** Control of eukaryotic gene expression at the level of Chromatin, Transcription, post transcriptional gene regulation and control at the level of translation. Nuclear transport and importance in gene regulation	14
2	**Cellular Signaling and Communication:** Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing. Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	15
3	**Cell Cycle and Regulation:**Cell division and cell cycle: introduction, Regulation of the cell cycle by Cell growth and extracellular signals, Cell cycle checkpoints and regulation, Protein kinases and cell cycle Progression, Cyclins and cyclin dependent Kinases and cell cycle, DNA Damage checkpoint and spindle assembly checkpoint and cell division, Meiosis and regulation of Meiosis	06
4	**Molecular Basis of Cancer:**Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	04

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Molecular Biology of the Cell, 6th Edition by Bruce Alberts ,Alexander Johnson ,Julian Lewis, Martin Raff , Keith Roberts and Peter Walter ,Publisher: Garland Science	2014
2	The Cell: A Molecular Approach, Seventh Edition , by Geoffrey M. Cooper , Robert E. Hausman Publisher: Sinauer Associates, Inc.	2015
3	Cell and Molecular Biology, seventh edition by Karp, Gerald, Publisher Wiley and sons, incorporation	2013
4	Molecular Biology of the Cell, **6**th Edition by Bruce Alberts ,Alexander Johnson ,Julian Lewis, Martin Raff , Keith Roberts and Peter Walter , Publisher: Garland Science	2022
Reference Books		
1	Molecular Cell Biology ,6th Edition by Harvey Lodish , Arnold Berk , Chris A. Kaiser , Monty Krieger , Matthew P. Scott , Anthony Bretscher , Hidde Ploegh , Paul Matsudaira, Publisher: W. H. Freeman	2007
2	Molecular Biology of the Cell, 5th Edition by Bruce Alberts ,Alexander Johnson ,Julian Lewis, Martin Raff , Keith Roberts and Peter Walter , Publisher: Garland Science	2007

Course Outcome

Sr	Course Outcome	CO
	After successful completion of this course, students will be able to:	
1	Understand how gene expression is controlled in eukaryotes at different levels with relation to normal cellular functions.	CO1
2	Understand in detail cellular communications and how are different pathways of signal transduction important as far as the cell survival is concerned.	CO2
3	Understand the importance of cell cycle and its regulation	CO3
4	Gain insights about the molecular basis of cancer and therapeutic interventions for control of Cancer.	CO4

Course Code : **BTP 6022**
Course Title : **Cell and Molecular Biology-II Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Departmental Core Course**
Pre-requisite Courses (if any) : **Nil**
Equal Course Code (if any) : **Nil**
Equivalent Course Code (if any) : **Nil**

List of Experiments

Sr	Contents
1	General introduction about lab and preparation of solutions/Reagents and culture media
2	Isolation of genomic DNA from different plant tissues
3	Agarose Gel Electrophoresis of DNA
4	Isolation of genomic DNA from *E. coli* cells
5	Isolation of plasmid DNA from *E. coli* cells
6	Spectrophotometric analysis of DNA
7	Restriction digestion of DNA and plasmid DNA
8	Preparation of Competent cells of *E. coli*
9	Transformation of competent *E. coli* cells
10	Isolation of total RNA
11	Ultra purification of plasmid DNA by CsCl density gradient centrifugation
12	Thermal denaturation of DNA

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Molecular Cloning: A Laboratory Manual, 4th edition, Joseph Sambrook, David W. Russell, Publisher: Cold Spring Harbor Laboratory	2012
2	Current Protocols in Molecular Biology, Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith, Kevin Struhl (eds.), Publisher: John Wiley & Sons, Inc.	2003
3	Molecular Cloning. A Laboratory Manual. 2nd Edition. Joseph Sambrook, E F Fritsch, and T.Maniatis, publisher: Cold Spring Harbor Laboratory.	1989
Reference Books		
1	Gene Cloning and DNA Analysis an Introduction Eighth Edition, T.A. BROWN publisher: John Wiley & Sons, Ltd.	2020

Course Outcome

Sr	Course Outcome	CO
	After successful completion of this course, students will be able to:	
1	Understand the basic techniques and functioning of equipment required for molecular Biology lab	CO1
2	Isolate and purify Genomic DNA, Plasmid DNA and RNA from different samples	CO2
3	Analyze the Genomic DNA, Plasmid DNA and RNA by qualitative and quantitative methods	CO3
4	Perform and analyze experiments related to restriction digestion and transformation of *E. coli*	CO4

Course Code : **BTL 6201**
Course Title : **Plant Cell Culture**
L-T-P/S=Credits : **2-0-0 =2**
Course Category : **Science Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**UNIT-I: Introduction to Plant Cell Culture :**Introduction: historical background, advantages and limitation of tissue culture; concepts & basic techniques in tissueculture; conventional breeding vs tissue culture; tissue culture media (composition & preparation), sterilization techniques.	7
2	**UNIT-II: Propagation Through Cell Culture:** Initiation and maintenance of callus and suspension cultures, differentiation, organogenesis & somaticembryogenesis, Production and application of artificial seeds. Shoot tip culture for rapid clonal propagation & production of virus-free plants, stages of micropropagation.	7
3	**UNIT-III: Plant Improvement Through Cell Culture:** Importance of variability, somaclonal and gametoclonal variations, practical application of somaclonal variations Protoplast isolation, fusion & culture, somatic hybridization, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids.	6
	Unit-IV: Applications of Cell Culture: Haploid production and its significance, ovary, pollen culture, Embryo culture / embryo rescue, role of haploids in agriculture. Germplasm preservation & storage; Plant secondary metabolites, synthesis & extraction, central mechanism and manipulation using plant cell and tissue cultures.	6

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Culture of Animal Cells,R. Ian Freshney, Wiley-Blackwell publications.	2016
2	Animal Cell Culture- Practical Approach, John R.W. Masters, OxfordUniversityPress.	2000
3	Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.	1998
4	Animal Cell Biotechnology, Methods and protocols, Nigel Jenkins, Humana Press.	1999

Course Outcome

Sr	Course Outcome	CO
1	Understand the advantages and limitations of tissue culture, biology of cultured cells and laboratoryrequirements for plant cell culture.	CO1
2	Uunderstand the aseptic technique necessary for performing plant/animal cell culture experiments.	CO2
3	Understand the physicochemical properties and components of the cell culture media.	CO3
4	Demonstrate knowledge of primary cell culture establishment, cell culture maintenance and the generaltechniques of cell culture.	CO4
5	Describe the main aspects of cell quantification, scale up methods, cryopreservation techniques performedin cell culture.	CO5
6	Understand the applications of plant cell culture types and various techniques of culturing.	CO6
7	Understand the principles and procedures of plant cell hybridization	CO7

Course Code : **BTL 6191**
Course Title : **Animal Cell Culture**
L-T-P/S=Credits : **2-0-0 =2**
Course Category : **Science Course**
Pre-requisite Courses (if any) :
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Biology of cultured cells, aseptic techniques, andculture media:** Introduction: historical background, advantages and limitation of tissue culture. Biology of Cultured Cells, Different equipment used in cell culture laboratory, Aseptic Technique: objectives, elements of aseptic environment, sterile handling, standard procedures, apparatus and equipment; Culture vessels and substrates.Cell culture media and supplements: physicochemical properties, balanced salt solutions, complete media; Importance of serum and serum-free media, adaptation to serum free media. Role of CO2 in cell culture.	9
2	**Primary and cell line cultures, and basic techniques:**Primary and cell line cultures: Tissue disaggregation and primary culture establishment; Subculture and cell lines: difference between cell line and strain, cell line designations, Maintenance and subculturing cell culture. Cell cloning and separation methods, cells transformation, cell immobilization and cell synchronization. Contamination types, detection and removal; Cryopreservation and transportation of cells; Measurement of growth and viability of cells in culture.	9
3	**Scale up methods and applications of animal cellculture:**Scale up methods for propagation of anchorage-dependent and suspension cell culture.Applications of animal cell culture; stem cell cultures, embryonic stem cells, induced pluripotent stem cells and their applications; cell micromanipulation, animal and human cloning. Organ and histotypic cultures.	8

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Culture of Animal Cells,R. Ian Freshney, Wiley-Blackwell publications.	2016
2	Animal Cell Culture- Practical Approach, John R.W. Masters, OxfordUniversityPress.	2000
3	Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.	1998
4	Animal Cell Biotechnology, Methods and protocols, Nigel Jenkins, Humana Press.	1999

Course Outcome

Sr	Course Outcome	CO
1	Understand the advantages and limitations of tissue culture, the biology of cultured cells; describe the laboratory requirements for cell culture; apply the aseptic technique necessary for performing animal cell culture.	CO1
2	Understand the physicochemical properties and components of the animal cell culture media.	CO2
3	Demonstrate knowledge of primary cell culture establishment, cell culture maintenance, and the general cell culture techniques.	CO3
4	Describe the scale up methods and applications of animal cell culture.	CO4

Course Code : **BTP 6176**
Course Title : **Cell Culture Lab(Common for Plant & Animal Cell Culture)**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Core Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents
1	To study the morphology of flowering plants
2	To study the germination of seeds
3	Acquaintance to aseptic technique and cell culture laboratory equipment.
4	Preparation of different culture media and reagents, apparatus and materials, sterilization of apparatus andliquids.
5	To study shoot regeneration by using shoot tip explants
6	Callus induction
7	Preparation of synthetic seeds
8	To prepare sections of anther, pollen and culture morphology and observe them under microscope
9	Haploid culture
10	Extraction of secondary metabolites and their qualitative and quantitative analysis
11	Preparation of cell culture media Primary cell culture establishment.
12	Cell counting and cell viability testing.
13	Maintenance and sub culturing of cultured cells.
14	Cryopreservation and thawing.
15	Measurement of cell growth.
16	Detection of apoptosis in cultured cells.
17	Cell cloning in microtitration plates

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Kuby Immunology, Judy Owen, Jenni Punt & Sharon Stranford. 7th Edition, WH Freeman & Co., 2013	2013
2	Immunology: Understanding The Immune System, 2nd Edition, Klaus D Elgert, Wiley-Blackwell Publishers,2009.	2009
3	Cellular and Molecular Immunology, 9th Edition, Abul Abbas, Andrew H Lichtman & Shiv Pillai, Elsevier,2017.	2017
4	Culture of Animal Cells,R. Ian Freshney, Wiley-Blackwell publications.	2016
5	Animal Cell Culture- Practical Approach, John R.W. Masters, OxfordUniversityPress.	2000
6	Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.	1998
7	Animal Cell Biotechnology, Methods and protocols, Nigel Jenkins, Humana Press.	1999

Course Outcome

Sr	Course Outcome	CO
1	Understand the basics of immune system and its protective mechanisms.	CO1
2	Know the basis and development of cellular and humoral immunity.	CO2
3	Know the structure and function of immune effector molecules viz. Antibodies, T cell Receptor.	CO3
4	Understand the molecular basis of hypersensitivity and autoimmunity.	CO4
5	Comprehend the basis of vaccines and organ transplants.	CO5
6	Understand the role of immune system in cancer and HIV-AIDS and antigen antibody interactions.	CO6
7	Know the process of antigen presentation and MAB production.	CO7
8	Understand the advantages and limitations of tissue culture, the biology of cultured cells; describe the laboratory requirements for cell culture; apply the aseptic technique necessary for performing animal cell culture.	CO8
9	Understand the physicochemical properties and components of the animal cell culture media.	CO9
10	Demonstrate knowledge of primary cell culture establishment, cell culture maintenance, and the general cell culture techniques.	C10
11	Describe the scale up methods and applications of animal cell culture.	C11

Course Code : **BTL 6182**
Course Title : **Principles of Immunology**
L-T-P/S=Credits : **3-0-0 =2**
Course Category : **Core Course**
Pre-requisite Courses (if any) :
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents
1	Unit-I Basics of Immunology: Immune System - Innate Immune response and Adaptive Immune response, Humoral and cellular component of theImmune response., The lymphoid organs, their interaction Antigens, Epitopes and Immunogenicity. Antibody- structure, function, diversity, engineering
2	Unit-II MHC and T-cell Activation : Major histocompatibility complex- MHC molecules structure and function of gene products and organisation of their genes. Antigen presentation. T Cell receptor-structure and interaction with MHC I and MHC II. Organization of TCR gene segments, Activation of T cells and apoptosis
3	Unit-III : B-cells and Cell Mediated Immune Response: B-cell maturation. Complement System Cytokines-structure, function and receptors. Cell mediated effector responses. Hypersensitivity, Autoimmunity Infectious diseases
4	Unit-IV Immunology: Organ Transplantation, graft vs host rejection, immunosuppression and immunomodulation, AIDS, Tumor immunology, Hybridoma technology and monoclonal antibodies production, Vaccine development, DNA vaccine, principle of diagnostic kits.

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Kuby Immunology, Judy Owen, Jenni Punt & Sharon Stranford. 7th Edition, WH Freeman & Co., 2013	2013
2	Immunology: Understanding The Immune System, 2nd Edition, Klaus D Elgert, Wiley-Blackwell Publishers,2009.	2009
3	Cellular and Molecular Immunology, 9th Edition, Abul Abbas, Andrew H Lichtman & Shiv Pillai, Elsevier,2017.	2017

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Course Outcome

Sr	Course Outcome	CO
	After successful completion of this course, students will be able to:	CO1
1	Understand the basics of immune system and its protective mechanisms.	CO2
2	Know the basis and development of cellular and humoral immunity.	CO3
3	Know the structure and function of immune effector molecules viz. Antibodies, T cell Receptor.	CO4
4	Understand the molecular basis of hypersensitivity and autoimmunity.	CO5
5	Comprehend the basis of vaccines and organ transplants.	CO6
6	Understand the role of immune system in cancer and HIV-AIDS and antigen antibody interactions.	CO7
7	Know the process of antigen presentation and MAB production	CO8

Course Code : **BTP 6185**
Course Title : **Principals of Immunology Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Departmental Core Course**
Pre-requisite Courses (if any) : **Nil**
Equal Course Code (if any) : **Nil**
Equivalent Course Code (if any) : **Nil**

List of Experiments

Sr	Contents
1	Laboratory Rules for the Principles of Immunology Lab course and working with pipettes.
2	Perform the total leukocyte count and differential leukocyte count.
3	Perform precipitation reactions in gel by Ouchterlony Technique (double immunodiffusion) of given anantigen and antibody.
4	Perform single radial immunodiffusion (Mancini's Technique) using an antigen and antibody.
5	To learn the technique of rocket immunoelectrophoresis (RIEP)
6	To learn the technique of immunoelectrophoresis
7	To determine the blood group and Rh factor of an individual
8	To learn the ELISA technique
9	Separation and purification of antibodies from serum
10	To perform Polyacrylamide gel electrophoresis (SDS-PAGE) of purified antibody
11	To learn the Western Blotting technique

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Immunology: Understanding The Immune System, 2nd Edition, Klaus D Elgert, Wiley-Blackwell Publishers,2009.	2009
2	Cellular and Molecular Immunology, 9th Edition, Abul Abbas, Andrew H Lichtman & Shiv Pillai, Elsevier,2017.	2017

Course Outcome

Sr	Course Outcome	CO
	After successful completion of this course, students will be able to:	
1	Comprehend the basis of vaccines and organ transplants.	CO1
2	Understand the role of immune system in cancer and HIV-AIDS and antigen antibody interactions.	CO2
3	Know the process of antigen presentation and MAB production	CO3

Course Code : **BTL 7152**
Course Title : **Genetic Engineering and Applications**
L-T-P/S=Credits : **3-0-0 =3**
Course Category : **Departmental Core Course**
Pre-requisite Courses (if any) : **Nil**
Equal Course Code (if any) : **Nil**
Equivalent Course Code (if any) : **Nil**

Detailed Syllabus

Sr	Contents	Approx. ContactHours
1	**Tools in Gene cloning:** Isolation and purification of nucleic acids. Restriction enzymes- properties and uses in recombinant DNA technology. Gene cloning vectors: Plasmids, bacteriophages, phagemid, Cosmid, binary vectors, artificial chromosomes: YAC, BAC, PAC, MAC, TAC and other commonly used vectors in microbes, plants and animals.	10
2	**Polymerase Chain reaction and DNA Sequencing:** Concept and applications of PCR, RT-PCR, Q-PCR., RACE. Sequencing of nucleic acids. Radiolabeling of DNA, Nucleic acid hybridization, DNase-I-foot printing, functional analysis of promoters.	10
3	**Gene Cloning strategies:** cDNA synthesis, Gene Libraries, construction of recombinant DNA with plasmids, cloning in plasmids, construction of DNA libraries with phages, construction of genomic libraries in Cosmid vectors, screening of recombinants, use of selectable and scorable markers, characterization of recombinants.	10
4	**Applications of Genetic engineering:** Genetic transformation of eukaryotes – genetic transformation of plants and animal cells. Transgenic animals, production of recombinant pharmaceuticals, gene therapy, disease diagnosis.	9

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	GENE CLONING AND DNA ANALYSIS: AN INTRODUCTION, 8TH EDITION, T. A. BROWN	2020
2	Principles of Gene Manipulation and Genomics, 7thEdition, Primrose SB and Twyman RM, Blackwell Publishing, Oxford,UK, 2006.	2006
3	An Introduction to Genetic Engineering, Third edition, Desmond S. T. Nicholl , Published by Cambridge University Press	2012
Reference Books		
1	Biotechnology-Applying the Genetic Revolution, Clark DP and Pazdernik NJ, Elsevier Academic Press.	2009
2	Molecular Biotechnology - Principles and Applications of recombinant DNA, Glick BR and Pasternak JJ, ASM Press, Washington.	2003

Course Outcome

Sr	Course Outcome	CO
	After successful completion of this course, students will be able to:	
1	Understand basic principles of recombinant DNA technology and the tools and techniques involved in gene cloning.	CO1
2	Understand the technique of PCR and DNA sequencing for various application purposes.	CO2
3	Illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.	CO3
4	Apply recombinant DNA technology in biotechnological research.	CO4

Course Code : **BTP 7152**
Course Title : **Genetic Engineering and Applications Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Departmental Core Course**
Pre-requisite Courses (if any) : **Nil**
Equal Course Code (if any) : **Nil**
Equivalent Course Code (if any) : **Nil**

List of Experiments

Sr	Contents
1	Cloning of foreign DNA in plasmid.
2	Southern blotting and hybridization.
3	Northern blotting of RNA.
4	PCR technique.
5	Nucleotide sequencing.
6	Demonstration of promoter activity.
7	*Agrobacterium tumefaciens* mediated plant transformation.
8	Construction of genomic and cDNA library.

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication/Reprint
Text Books		
1	Molecular Cloning: A Laboratory Manual, 4th edition, Joseph Sambrook, David W. Russell, Publisher: Cold Spring Harbor Laboratory	2012
2	Current Protocols in Molecular Biology, Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith, Kevin Struhl (eds.), Publisher: John Wiley & Sons, Inc.	2003
3	Molecular Cloning. A Laboratory Manual. 2nd Edition. Joseph Sambrook, E F Fritsch, and T.Maniatis, publisher: Cold Spring Harbor Laboratory.	1989
Reference Books		
1	Gene Cloning and DNA Analysis an Introduction Sixth Edition, T.A. BROWN publisher: John Wiley & Sons, Ltd.	
2		

Course Outcome

Sr	Course Outcome	CO
	After successful completion of this course, students will be able to:	
1	Understand and perform the basic techniques involved in gene cloning experiments.	CO1
2	Perform the experiment related to Southern and Northern Blotting	CO2
3	Perform and set up a Polymerase chain reaction and to analyze the results of PCR reaction.	CO3
4	Construct Genomic/c-DNA libraries for the screening of desired gene/s	CO4

Course Code : **BTL 6091**
Course Title : **Molecular Genetics**
L-T-P/S=Credits : **3-1-0 =4**
Course Category :**Core Course**
Pre-requisite Courses (if any) :
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	Concept of the gene : Evolution of the one gene – one polypeptide concept, Discovery ofrecombination within the gene, Complementation test, Colinearity of gene and polypeptide Genomic variations – SNPs, RFLPs, Tandem repeat polymorphisms, Copy number polymorphisms	9
2	Linkage Crossing – Over, Molecular mechanisim, Chromosome mapping Gene transfer in Bacteria: History, Transduction – generalized and specialized, Conjugation– F, F', Hfr, F transfer, Hfr-mediated chromosome transfer, Transformation – natural and artificial transformation, Merodiploid generation, Interrupted gene mapping, Genetic analysis using phage and plasmid	9
3	Mendelian Genetics: Principles, Mendelian experiments, Probability in mendelian inheritance,Patterns of single gene inheritance, autosomal recessive, autosomal dominant, sex-linked inheritance, pedigree analysis	9
4	Population and Evolutionary genetics: Allele frequencies, Hardy – Weinberg principle, Processes altering allele frequencies, Genetic equilibrium, Speciation, Patterns and modes ofsubstitutions, Molecular clocks, Concepts of molecular phylogeny	9
5	Genetic marker techniques – RFLP, RAPD, AFLP, SSR, ISSR, VNTRs, CAPS, SNP, SSCP, DNA microarrays, FISH, RNA interference, Applications of genetic markers, Genetic and physical genome mapping	8
6	Basic concepts of development: Potency, commitment, specification, induction, competence,determination & differentiation; morphogenetic gradients; cell fate & cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants & transgenics in analysis of development. Genes in early development, Maternal effect genes, Pattern formation genes, Homeotic genes	8

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Principles of Genetics by Gardner ,Simmons and Snustad , 8th Edition; published byJohn Wiley & Sons Inc., 1991	1991
2	Microbial Genetics ,David Freifelder ,Narosa publishing House ,1995	1995
3	Principles of Developmental Genetics by Sally A. Moody	
4	Developmental Biology, Eighth Edition by Scott F. Gilbert	
5	Genetics – A molecular approach, P. Russell, Pearson Benjamin Cummings	
6	Genetics – Analysis of genes and genomes, Hartl and Jones, Jones and Bartlett	
7	Genetics, Strickberger, Pearson Education	
8	Concepts of genetics, Klug and Cummings, Pearson Education	

Course Outcome

Sr	Course Outcome	CO
1	Take a family history, construct a pedigree and describe patterns of inheritance.CO2. Understand the concept of gene evolution.	**CO1**
2	Understand the concept of gene evolution	**CO2**
3	Understand the methods and applications of recombination in bacteria.	**CO3**
4	Understand the application of genetics in various perspectives sucah as evolution , development and medicine	**CO4**
5	Understand the impact of genetic variations on development of genetic diseases and their applications asgenetic markers.	**CO4**

SEMESTER-III

Course Code : BTL 7222
Course Title : Computational Biology & Bioinformatics
L-T-P/S=Credits : 3-0-0 =3
Course Category :Core Course
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Unit-I Introduction to Biological Data Bases:** Introduction to databases: Concepts, Sequence structure and Derived databases (Genebank, EMBL, Swiss prot and PDB). Database access and retrieval tools ENTREZ, SRS. Information system; NCBI, EBI, BTIs, The Protein Data Bank (PDB) and the Nucleic Acid Data Bank (NDB).	10
2	**Unit-II Algorithm and Sequence Alignment:** Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, Needleman-Wunsch& Smith-Waterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method.Theory of scoring matrices and their use for sequence comparison.	10
3	**Unit-III Bioinformatics of Biophysical Techniques:** Experimental Methods for Molecular Structure Determination: Brief account of structure determination by X-ray crystallography and NMR spectroscopy. Validation of experimentally obtained NMR structures, Introduction to genomics, functional and structural genomics, sequencing strategies for whole genome analysis, sequence data analysis, Comparative genomics, genome annotation	10
4	**Unit-IV Proteomics and Genomics:** Strategies in proteomics. Structural/functional proteomics. Computational approach for studying protein–protein interactions, Proteomics methodologies, Proteomics applications: drug development, screening of diagnostic markers, identification and characterization of novel proteins. Global analysis of gene expression.Transcriptomics and microarray.Toxicogenomics. Pharmacogenomics.	09

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Discovering Genomics, Proteomics, and Bioinformatics, A Malcolm Campbell &Laurie J Heyer, 2nd Edition, Pearson, 2007.	2007
2	Bioinformatics: Sequence and Genome Analysis, David Mount, 2nd Edition, CSHL Press, 2004.	2004
3	Bioinformatics: A Practical Guide to the Analysis of Genes andProteins, 3rd Edition, Andreas D Baxevanis& BF Francis Ouellette, Wiley, 2004	2004
4	A Bioinformatics Guide for Molecular Biologists, Sarah Aerni& Marina Sirota, CSHL Press, 2014.	2014
5	Genomes, 2nd Edition, TA Brown, Oxford: Wiley, 2002.	2002

Course Outcome

Sr	Course Outcome	CO
1	Know the usage of various biological databases.	**CO1**
2	Know about sequence comparison methods and their merits and demerits.	**CO2**
3	Understand the techniques used in genomics and proteomics.	**CO3**
4	Know the applications of genomics and proteomics.	**CO4**
5	Comprehend basis of protein structure determination.	**CO5**

Course Code : **BTP 7225**
Course Title : **Computational Biology & Bioinformatics Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Core Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents
1	An introduction to the computing platforms.
2	Molecular databases and how they are organized and accessed.
3	Unknown DNA -- rational probe design and analysis.
4	DNA fragment contig assembly and restriction enzyme mapping.
5	Database similarity searching and the dynamic programming algorithm.
6	Gene finding strategies. How are coding sequences recognized in genomic DNA.
7	Multiple sequence alignment, expectation maximization, profiles, and Markov models.
8	Molecular evolutionary phylogenetic inference.
9	Estimating protein secondary structure and physical attributes.
10	Molecular modelling and visualization.

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Discovering Genomics, Proteomics, and Bioinformatics, A Malcolm Campbell &Laurie J Heyer, 2nd Edition, Pearson, 2007.	2007
2	Bioinformatics: Sequence and Genome Analysis, David Mount, 2nd Edition, CSHL Press, 2004.	2004
3	Bioinformatics: A Practical Guide to the Analysis of Genes andProteins, 3rd Edition, Andreas D Baxevanis& BF Francis Ouellette, Wiley, 2004	2004
4	A Bioinformatics Guide for Molecular Biologists, Sarah Aerni& Marina Sirota, CSHL Press, 2014.	2014
5	Genomes, 2nd Edition, TA Brown, Oxford: Wiley, 2002.	2002

Course Outcome

Sr	Course Outcome	CO
1	Understand the techniques used in genomics and proteomics.	**CO1**
2	Know the applications of genomics and proteomics.	**CO2**
3	Comprehend basis of protein structure determination.	**CO3**

Course Code : **BTL 6272**
Course Title : **Appled Enzyme Catalysis**
L-T-P/S=Credits : **3-0-0 =3**
Course Category :**Core Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Unit-I** **Introduction and Classification of Enzymes:** Introduction: Discovery, classification and nomenclature of enzymes. Calculate enzyme activity, cofactors, coenzymes, prosthetic groups and enzyme specificity. Application of free enzymes in food and feed, detergents and textiles, pulp and paper, pharmaceuticals, diagnostics, Isoenzymes and nature of active sites identification of functional groups at active sites. Isolation and purification of enzymes.	10
2	**Unit-II** **Kinetics and Mechanism of Action of Enzymes:** Mechanism enzyme catalysis: Covalent catalysis, nucleophilic and electrophilic catalysis.Factors responsible for catalytic efficiency of enzymes, i.e proximity and orientation effectsMechanism of action of selected enzymes i.e chymotrypsin, lysozyme, trypsin, ribonuclease. Kinetics of enzyme Catalyzed reaction: Concept of Es complex, Michaelis-Menten equation for unisubstrate reactions. Importance of Kcat/km. Different plots for determination of Km &Vmax and their physiological significances, Classification and derivation of multi substrate reactions with examples of each class. Significance of energy of activation. Collision and transition state theory.Induced fit hypothesis.	10
3	**Unit-III** **Inhibitors and Activators of Allosteric Enzymes:** Reversible and irreversible inhibitiors, determination of Ki .Effect of pH and temperature on enzyme catalyzed reactions. Enzyme regulation: allosteric enzymes positive and negative cooperativity.	10
4	**Unit-IV** **Enzyme Immobilization:** Immobilization techniques and influence of immobilization on enzyme activity. Production and application of immobilized enzymes in food and feed, detergents and textiles, pulp and paper pharmaceutical diagnostics.	09

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Enzymes, Biochemistry, Biotechnology, Clinical chemistry: Trevor Palmer, Philip L &Booner	
2	Enzyme Technology, Ashok Pandey. Asia Tech publishers.	
3	Fundamentals of Enzymology, Nicolas Price. Oxford University Press	
4	Practical Enzymology- H. Bisswanger	
5	Principles and Techniques ofBiochemistry and Molecular Biology- K. Wilson, J. Walker	
6	Enzyme Assays: A Practical Approach- R. Eisenthal, M. Danson	
7	Enzyme Stabilization and Immobilization: Methods and Protocols- S. D. Minteer	

Course Outcome

Sr	Course Outcome	CO
1	Explain the role of enzymes in biological sciences.	**CO1**
2	Define application of enzymes in industries and isolate and assay enzyme activity from microbes	**CO2**
3	Perform Chromatographic techniques for purification of protein of interest.	**CO3**
4	Check the effect of temperature and pH on enzyme activity and carry out enzyme immobilization and perform assay of immobilized enzyme	**CO4**
5	Check the inhibition and activation of enzyme.	**CO5**
6	Explain the kinetics of enzyme catalyzed reaction.	

Course Code : **BTP 6275**
Course Title : **Appled Enzyme Catalysis Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Core Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents
1	Introduction to Enzymology lab, basic practices & equipment usage.
2	Qualitative test for enzyme assay (plate assay method)
3	Assay of enzyme activity.
4	Influence of substrate concentration on the rate of enzymatic reaction.
5	Effect of pH on the rate of enzyme reaction.
6	Effect of temperature on the rate of enzyme reaction.
7	Inhibition of enzyme activity.
8	Activation of enzyme activity.
9	To study kinetics of enzyme catalyzed reaction.
10	Entrapment of Enzyme in Alginate Beads.
11	To study the kinetics of the rate of enzymatic reaction by enzyme entrapped alginate beads.
12	Isolation and purification of Enzyme.

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Enzymes, Biochemistry, Biotechnology, Clinical chemistry: Trevor Palmer, Philip L &Booner	
2	Enzyme Technology, Ashok Pandey. Asia Tech publishers.	
3	Fundamentals of Enzymology, Nicolas Price. Oxford University Press	
4	Practical Enzymology- H. Bisswanger	
5	Principles and Techniques ofBiochemistry and Molecular Biology- K. Wilson, J. Walker	
6	Enzyme Assays: A Practical Approach- R. Eisenthal, M. Danson	
7	Enzyme Stabilization and Immobilization: Methods and Protocols- S. D. Minteer	

Course Outcome

Sr	Course Outcome	CO
1	Check the effect of temperature and pH on enzyme activity and carry out enzyme immobilization and perform assay of immobilized enzyme	**CO1**
2	Check the inhibition and activation of enzyme.	**CO2**
3	Explain the kinetics of enzyme catalyzed reaction.	**CO3**

Course Code : **BTL 7234**
Course Title : **Bioprocess Engineering and Technology**
L-T-P/S=Credits : **3-1-0 =4**
Course Category : **Core Course**
Pre-requisite Courses (if any) : **Biochemistry and Microbiology**
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**OPERATION AND CONTROL OF BIOREACTORS:** Types of Fermentation Processes: Analysis of batch, fed-batch and continuous bioreactors, stability of microbial bioreactors, analysis of mixed populations, specialized bioreactors-pulsed, fluidized, photo bioreactors, etc. Measurement and Control of bioprocess parameters. Downstream processing, Whole cell immobilization and their industrial applications.	13
2	**MICROBIAL CELL GROWTH AND DEATH KINETICS:** Screening and Improvement of industrially important microorganisms, Microbial Growth and Death Kinetics, Media for Industrial Fermentation, Air and Media Sterilization.	13
3	**FERMENTATION TECHNOLOGY: INDUSTRIAL PRODUCTION OF CHEMICALS:** Ethanol, Acids (citric, acetic and gluconic acid), Solvents (glycerol, acetone, butanol), Antiobiotics (penicillin, streptomycin, tetracyclin), Semi-synthetic antibiotics, Amino acids (lysine, glutamic acid), Single cell protein.	13
4	**APPLICATIONSOF BIOPROCESS ENGINEERING:** Agitation and aeration: requirement in industrial processes, concept of volumetric oxygen transfer coefficient and its determination (K_{la}), Factors affecting K_{la} values; Uses of microbes in mineral beneficiation and oil recovery. Introduction to food technology; Elementary idea of canning and packaging, Sterilization and pasteurization of food products.	13

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Bioprocess Engineering, Shular M& Kargi F, Prentice Hall	2021
2	Bioprocess Engineering Principles, Doran, PM,Academic Press, California	1995
3	Principles of Fermentation Technology, StanburyPF, Whitaker A& Hall SJ. Butterworth Heinmann, Elsevier	2016
4	Biotechnology-A Textbook of Industrial Microbiology, Crueger W& Crueger A, Sinear Associates	2017
5	Biochemical Engineering, James M. Lee, Prentice Hall	1992

Course Outcome

Sr	Course Outcome	CO
1	Present unit operations together with fundamental principles for basic methods in production techniques for biologically based products	CO1
2	Evaluate the kinetics and thermodynamics of microbial process	CO2
3	Select and design a bioreactor and undertake bioprocess monitoring/control	CO3
4	Describe equipment, materials and methods related to biotechnological processes	CO4
5	Give an account of important industrial biochemicals and perform competently in biotech industries	CO5
6	Gain ability to investigate, design and conduct experiments.	CO6

Course Code : **BTP 6275**
Course Title : **Bioprocess Engineering and Technology Lab**
L-T-P/S=Credits : **0-0-3 =1.5**
Course Category : **Core Course**
Pre-requisite Courses (if any):
Equal Course Code (if any) :
Equivalent Course Code (if any) :

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	1. To plot microbial growth curve for shake flask culturing using turbidity method. 2. To isolate invertase enzyme and find its activity from Baker's Yeast 3. Quantitative estimation of ethanol produced during Yeast fermentation 4. Production of citric acid by fermentation. 5. To get familiarized with the lab scale fermenter (bench top fermenter) 6. To determine dissolved oxygen concentration in tap and aerated water.	12

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Bioprocess Engineering, Shular M& Kargi F, Prentice Hall	2021
2	Bioprocess Engineering Principles, Doran, PM,Academic Press, California	1995
3	Principles of Fermentation Technology, StanburyPF, Whitaker A& Hall SJ. Butterworth Heinmann, Elsevier	2016
4	Biotechnology-A Textbook of Industrial Microbiology, Crueger W& Crueger A, Sinear Associates	2017
5	Biochemical Engineering, James M. Lee, Prentice Hall	1992

Course Outcome

Sr	Course Outcome	CO
1	Select and design a bioreactor and undertake bioprocess monitoring/control	**CO1**
2	Describe equipment, materials and methods related to biotechnological processes	**CO2**

Course Code : **BTE 7413**
Course Title : **Principles of Intellectual Property Rights & Biosafety**
L-T-P/S=Credits : **3-0-0 =3**
Course Category : **Elective-I**
Pre-requisite Courses (if any): NA
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**UNIT-I: Introduction to Intellectual Property Rights** Intellectual property, meaning, evolution, choice of intellectual property protection; Classification and forms; Rationale for protection of IPRs - Importance of IPRs in the fields of science and technology.	10
2	**UNIT-II: Types of IPR Rights** Types of IPRs - Patents, Copyrights, Trademarks, Trade secrets, Geographical indicators, Traditional Knowledge Digital Library; Plant/Animal variety protection act, Plant breeders rights; International conventions, WTO, GATT, TRIPs.	10
3	**UNIT-III: Patenting Processes** Patent claims, requirements of patentability, patentable subject matter, patent litigation, recent developments in patent system and patentability of biotechnological inventions; special issues in biotechnology patents, disclosure requirements.	10
4	**UNIT-IV: Biosafety Principles and Guidelines** Biosafety concepts and issues: Rational vs subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, biosafety levels, biosafety concerns at the level of individuals, institutions, society, region, country and the world; biosafety in the laboratory institution, laboratory associated infections and other hazards, prudent biosafety practices in the laboratory/institution; biosafety assessment procedures in India and abroad.	09

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1		
2		

Course Outcome

Sr	Course Outcome	CO
1	Describe the principles and choice for seeking various types of Intellectual Property Rights.	**CO1**
2	Identify the patentable and non-patentable materials.	**CO2**
3	Follow the correct procedures for filing of a patent.	**CO3**
4	Be aware of the principles and levels of Biosafety in Biotechnological research.	**CO4**
5	Be able to implement/design the proper containment facilities for a particular level of Biosafety in a given institution/industry.	**CO5**
6	Be aware about the various national and international guidelines of Biosafety	**CO6**

Course Code : **BTE 7402**
Course Title : **Drug Delivery and Pharmacokinetics**
L-T-P/S=Credits : **3-0-0 =4**
Course Category : **Elective-II**
Pre-requisite Courses (if any) : **NA**
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Unit-I** **Basics of Drug Delivery and Pharmacacokinetics:** Basics of Drug delivery, Routes of drug delivery, Introduction to Biopharmaceutics and Pharmacokinetics and their role in formulation development.	13
2	**Unit-II** **Modes of Drug Absorption and Kinetics:** Study of the different modes of drug absorption and Passage of drug across biological barrier, Pharmacokinetics of drug absorption (zero order, 1st order), Factors influencing absorption of drugs	13
3	**Unit-III** **Models of Drug Distribution, Elimination and Pharmacokinetic Principles:** Various theories of Drug distribution in the body, Compartment and non-compartment models, plasma protein binding, Volume of distribution and distribution coefficient.Pharmacokinetic principles, Bioavailability and Bioequivalence.Termination of drug action, Excretion, Biotransformation,Tissue redistribution	13
4	**Unit-IV** **Bioavailability and Drug Dose Calculation:** Measures of bioavailability, Pharmacokinetic parameters from plasma and urine data, C-max, and Area under curve (AUC), Calculation of LD50 & ED50, Therapeutic index and its role in dose adjustment	13

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1	Text Book of Biopharmaceutics& Clinical Pharmacokinetics, SarfarazNiazi, Appleton-Century-Crofts (ACC), New York.	
2	Pharmacokinetics and Metabolism in Drug Design, DA Smith, H Van de Waterbeemd& Don KWalker, Wiley VCH.	

Course Outcome

Sr	Course Outcome	CO
1	Understand the basics of drug delivery and different routes of drug delivery.	
2	Learn about the role of the Biopharmaceutics and Pharmacokinetics and their role in formulation development.	CO1
3	Understand different rate of drug absorption and their kinetics.	CO2
4	Understandvarious phenomenon involved in drug absorption, distribution and elimination from the body.	CO3
5	Calculate various kinetic parameters required in dose calculation and adjustments	CO4

Course Code : **BTC 7211**
Course Title : **Colloquium**
L-T-P/S=Credits : **1.5**
Course Category : **Core Course**
Pre-requisite Courses (if any) : **NA**
Equal Course Code (if any) : **NA**
Equivalent Course Code (if any) : **NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**UNIT-I: Report Submission and Presentation** Students shall submit the Project Report and deliver a Power Point Presentation batch-wise based on their work done during the summer training.	
2	**UNIT-II: Report Submission and Presentation (contd.)** Students shall submit the Project Report and deliver a Power Point Presentation batch-wise based on their work done during the summer training.	
3	**UNIT-III: Viva Voce and Group Discussion** The presentations and work done shall be reviewed for the whole class together during the group discussion.	

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1		
2		

Course Outcome

Sr	Course Outcome	CO
1	Identify topic appropriate research materials.	
2	Use correct form of scientific language.	CO1
3	Analyze and present appropriate research data generated by them in written and oral form.	CO2
4	Acquire hands-on training on ongoing fields of research.	CO3

SEMESTER- IV

Course Code **: BTD 7012**
Course Title **: Dissertation and Viva voce**
L-T-P/S=Credits **: 20**
Course Category **: Core Course**
Pre-requisite Courses (if any) **: NA**
Equal Course Code (if any) **: NA**
Equivalent Course Code (if any) **: NA**

Detailed Syllabus

Sr	Contents	Approx. Contact Hours
1	**Unit-I :** Literature studies followed by understanding of the research problem	
2	**Unit-II :** Conducting the experimental work	
3	**Unit-III :** Mid term presentation	
4	**Unit-IV :** Writing and submission of dissertation followed by final presentation	

Suggested Books:

Sr.	Name of Book, Author, Publisher	Year of Publication / Reprint
1		
2		

Course Outcome

Sr	Course Outcome	CO
1	Learn the identification of scientific problem	CO1
2	Conducting the scientific literature survey	CO2
3	Learn conducting the scientific experiments independently	CO3
4	Interpret the results of experiments and document them	CO4
5	Learn writing scientific reports	CO5

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