ADAMAS UNIVERSITY

SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY

Department of Biotechnology

M.Sc. (Biotechnology)

Program Code: BIT4201

(2024-25)

Total Credits – 88

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

VISION OF THEUNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinaryeducation, research and innovation, preparing socially responsible well-groundedindividuals contributing to nation building.

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology

M.S 02: Foster outcomes based education system for continuous improvement in education, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation

M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date

M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

VISION OF THE SCHOOL

To achieve global standard and **excellence in research**on various **interdisciplinary andmultidisciplinary domains**of biological sciences through **biotechnological innovation**along with **producing global citizens**as graduates by **intensive teaching learning process**who would be vanguard to **sustainable societal development**.

MISSION STATEMENTS OF THE SCHOOL

M.S01: Todisseminateknowledgeoflifescienceandbiotechnologyforscholarlyprogression, intellectual development and strive forinnovation.

M.S02: Toenablelatestskillsetsinthedomainofmicrobiology,biotechnology,biochemistry (biological sciences) with ability to evolve and engage in learn-unlearn and relearn, being a lifelonglearner.

M.S 03: To establish state of art infrastructure and research ambiance in attracting the best mindstoserveunderthesingleroofofschooloflifescienceandbiotechnologyinundertaking scientific investigation of socialrelevance.

04: Toinculcatevalues,culturealongwithscientificknowledgetofosterthespiritofself- reliance and entrepreneurshipdevelopment.

DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

VISION OF THEDEPARTMENT

Toachieve**excellenceinbiotechnologicaleducationandresearch**for**societaldevelopment**throu gh **innovation**and producing **technologically sound graduates**as **globalcitizen**fostering **life-longlearning.**

MISSION STATEMENTS OF THE DEPARTMENT

M.S 01: Adopt and implement latest curriculum in biotechnology with futuristic approach and innovative pedagogy fostering knowledge, intellectual and skill development.

M.S 02: To enable and enhance biotechnological and allied subject skill sets through rigorous training and research through multidisciplinary approach.

M.S 03: To cater professional and societal need of cutting-edge biotechnological research through collaboration and industry-academic partnership.

M.S 04: To inculcate values, culture along with biotechnological knowledge to foster the spirit of self-reliance and entrepreneurship development.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

Name of the Programme: M.Sc. Biotechnology

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 01 **:** Ability to exhibit research skills, comprehend fundamentals and professional expertise in the domain of biotechnology and allied subjects.

PEO 02 **:** Acquainted with modern tools and technology related to the field of biotechnological study.

PEO 03 **:** Innovative ability to find routes of solution of existing scientific problems of the domain through identification of research gaps.

PEO04 **:** Develop as professional aspirants and life-long learners**.**

PEO05 **:** Exhibit communication skills and ethical attributes as an effective team member in a competitive global environment.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF LIFE SCIENCE AND BIOTECHNOLOGY
DEPARTMENT OF BIOTECHNOLOGY

Name of the Programme: M.Sc. Biotechnology

GRADUATE ATTRIBUTE / PROGRAMME OUTCOMES (POs)

GA 01/ PO 01: Research and analysis: Develop research approaches to meet the scientific gaps on biotechnology and allied interdisciplinary or multidisciplinary fields.
GA 02/ PO 02: Academic excellence: Foster the knowledge and skills in biotechnology to identify and approach towards suitable solution.
GA 03/ PO 03: Data mining: Ability to salvage significant biological data for meaningful solution.
GA 04/ PO 04: Skills: Develop skill set related to biotechnology and allied fields.
GA 05/ PO 05: Modernization and tools usage: Familiarized with latest and advanced tools and techniques of biotechnology.
GA 06/ PO 06: Development of solutions: Investigate an existing problem to find suitable solutions, beneficial to the society**.**
GA 07/ PO 07: Diversity: Strong basic knowledge to support diversification in applied field of biotechnology.
GA 08/ PO 08: Professional: Ability to set career and professional goals based on a proper career planning process.
GA 09/ PO 09: Collaboration: Develop capacity to uphold integrity and collaborative approach in workplace.
GA 10/ PO 10: Sustainable learner: To accept and implement changes in learning towards a sustainable development through learn, unlearn-relearn approach.
GA 11/ PO 11: Ethics: Practice ethical philosophies and systems in creating and partnering a progressive society.
GA 12/ PO 12: Global perspectives: Develop as global citizen to contribute in the greater benefits of humanity.

HOD **DEAN / SCHOOLCONCERNED**

ADAMAS UNIVERSITY

School of Life Science and Biotechnology

Department of Biotechnology

M.Sc. Biotechnology (2 Years) Course Structure

Total Credits – 88

2024-25

Course Structure for M.Sc. Biotechnology (2 Years) Total Credits-88

ADAMAS UNIVERSITY							
DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - **I** **(Course Code: BIT)**							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**BIT21580**	**Theory Biomolecules and Biomolecular Interactions**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21502**	**Theory Biophysical Chemistry & Bioanalytical Techniques**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21590**	**Theory Applied Microbiology**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21504**	**Theory Molecular Genetics**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21581**	**Theory Ecology and Evolution**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21536**	**Bio-Ethics and Intellectual Property Rights**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT22582**	**Practical Biophysical Chemistry & Bioanalytical Techniques Lab**	**4**	**0**	**0**	**4**	**2**
CORE	**BIT22531**	**Practical Applied Microbiology and Molecular Genetics Lab**	**4**	**0**	**0**	**4**	**2**
Practical	**BIT22533**	**Professional Development course-1 (PDC-1)**	**2**	**0**	**0**	**1**	**1**
Total			**28**	**18**	**0**	**9**	**23**

ADAMAS UNIVERSITY							
DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER **- II**							
Type of thePaper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**BIT21509**	**Theory** **Molecular Biology**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21510**	**Theory** **Advanced Recombinant DNA Technology**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21591**	**Theory** **Applied Genomics and Proteomics**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21585**	**Theory** **Bioinformatics and Biostatistics**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT22586**	**Practical** **Molecular Biology and Recombinant DNA Technology Lab**	**4**	**0**	**0**	**4**	**2**
CORE	**BIT22532**	**Practical** **Applied Genomics and Proteomics Lab**	**4**	**0**	**0**	**4**	**2**
CORE	**BIT22516**	**Practical** **Bioinformatics Lab**	**4**	**0**	**0**	**4**	**2**
Core Elective (Discipline Specific)I	**BIT21517/ BIT21518/ BIT21520/ BIT21521**	**Cancer Biology (BIT21517)/Human Physiology (BIT21518)/Food and Dairy: Food Safety and Quality Control (BIT21520)/ Drug Design and Drug Development (BIT21521)** **Theory** **SELECT ONE TOPIC**	**3**	**3**	**0**	**0**	**3**
Practical	**BIT22534**	**Professional Development course-2 (PDC-2)**	**2**	**0**	**0**	**1**	**1**
Total			**29**	**15**	**0**	**13**	**22**

ADAMAS UNIVERSITY							
DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - III							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**BIT21588**	**Theory Immunotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21522**	**Theory Plant and Agricultural Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21524**	**Theory Animal Biotechnology**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT21525**	**Theory Process Biotechnology**	**3**	**3**	**0**	**0**	**3**
Core Elective (Discipline Specific)II	**BIT21589/ BIT21533/ BIT21534/ BIT21535**	**Nanobiotechnology (BIT21589)/ Advances in Stem Cell Research (BIT21533)/Pharmaceutical Biotechnology (BIT21534)/Research Methodology and GLP (BIT21535)**	**3**	**3**	**0**	**0**	**3**
CORE	**BIT22590**	**Practical Plant and Animal Biotechnology Lab**	**4**	**0**	**0**	**4**	**2**
CORE	**BIT22591**	**Practical Immunotechnology Lab**	**4**	**0**	**0**	**4**	**2**
CORE	**BIT22529**	**Practical Process Biotechnology Lab**	**4**	**0**	**0**	**4**	**2**
FOUNDATION	**BIT24530**	**Industry Internship***	**-**	**-**	**-**	**-**	**2**
Practical	**BIT22535**	**Professional Development course-3 (PDC-3)**	**2**	**0**	**0**	**1**	**1**
Total			**29**	**15**	**0**	**13**	**24**

*Industry Internship – the student will go for an internship between 2nd and 3rd semester.

ADAMAS UNIVERSITY							
DEPARTMENT OF BIOTECHNOLOGY – M.Sc. PROGRAM SEMESTER - **IV**							
Type of the Paper	**Paper Code**	**Theory / Practical**	**Contact Hours Per Week**	**L**	**T**	**P**	**Credit**
CORE	**BIT25540**	**Comprehensive Viva**	**-**	**-**	**-**	**-**	**4**
CORE	**BIT25541**	**Project Work and Viva**	**30**	**0**	**0**	**30**	**15**
Total			**30**	**0**	**0**	**30**	**19**

CORE ELECTIVE I (DSE) (Choose any one paper in Sem II) *		**CORE ELECTIVE II (DSE) (Choose any one paper in Sem III) ***	
1	Cancer Biology **(BIT21517)**	1	**Nanobiotechnology (BIT21589)**
2	Human Physiology **(BIT21518)**	2	Advances in Stem Cell Research **(BIT21533)**
3	Food and Dairy: Food Safety and Quality Control **(BIT21520)**	3	Pharmaceutical Biotechnology **(BIT21534)**
4	Drug Design and Drug Development (**BIT21521**)	4	Research Methodology and GLP (**BIT21535**)

* Offering of subjects will vary from year to year, subject to the availability of faculty Total Credits- 88

Semester	I	II	III	IV	Total Credits
Credits	23	22	24	19	88

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ADAMAS UNIVERSITY

SEMESTER I

BIT21580	Biomolecules and Biomolecular Interactions (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry and Cell Biology				
Co-requisites	--				

Course Objectives

1. The cells of living organisms encompass thousands of biomacromolecules. From this course the students will identify the structure-function relationship of these biomacromolecules.
2. The students will learn about the importance of the biomacromolecules with respect to maintenance and perpetuation of the livingsystems.

Course Outcomes

On completion of this course, the students will be able to
CO1: Analyze the various types of weak interactions between biomolecules and water.

CO2: Explain the structure of carbohydrates, amino acids, proteins, nucleic acids, and lipids.

CO3: Interpret the metabolic pathways involving biomolecules and the structure-function relationships of proteins.

CO4: Illustrate DNA sequencing techniques, principles of NGS, and the biosynthesis of purine and pyrimidine.

CO5: Describe lipidomics, fatty acid oxidation, and cholesterol biosynthesis in relation to physiological and metabolic events.

Catalogue Description

The core-course of 'Biomacromolecules &Biomolecular Interactions' will help to understand the structure and function of biomacromolecules: synthesis and properties of cellular macromolecules, basic properties of enzymes, principles of metabolism, bioenergetics, signal transduction, regulation of gene expression and function of biomolecules in cell structure and differentiation. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point

presentation, audio visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

Biomolecules and Biomolecular Interactions (BIT21580)

Unit I: Bonding and interactions (5h): Structure of atoms, molecules and chemical bonds, stabilizing forces of biomolecules.

Unit II: Carbohydrate (10h): Classification, structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans, glycoproteins and its significance. Hexose metabolism: pathways and energy metabolism. Metabolic labelling and glycomics.

Unit III: Amino acids and Proteins (13h): Structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran Plot, Protein folding and its kinetics, chaperones and folding pathways, Methods to study protein structure. Overview of amino acid biosynthesis. Techniques and concepts in proteomics: LC-MS/MS and peptide mass finger printing.

Unit IV Nucleic acids (8h): Nucleic acids as genetic information carriers, Forms and conformations of several orders of nucleic acid organizations: structure and function , Sequencing techniques and principle of NGS. Denaturation of DNA. Biosynthesis of purine and pyrimidine.

Unit V Lipids (9h): Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins, glycolipids. Fatty acid oxidation and cholesterol biosynthesis. Biosynthesis of saturated & unsaturated fatty acids and cholesterol. Lipidomics: sample preparation and analysis.

Suggested books:

1. Cell (A Molecular approach): Cooper , G. M.
2. Principle of Biochemistry: Leninger , A. L.
3. Biochemistry (1995) Lubert Stryer
4. Text Book of Biochemistry (1997) Devlin , Thomas M.
5. Biochemistry (1993) Geoffery, Zubay
6. Harper's Review of Physiological Chemistry(1993) Murray, R. K., Mayes, P. A. Gramner, D. K. and Rowell V. W.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Analyze** the various types of weak interactions between biomolecules and water.	**PO1, PO2**
CO2	**Explain** the structure of carbohydrates, amino acids, proteins, nucleic acids, and lipids.	**PO1, PO2, PO3,PO5**
CO3	**Interpret** the metabolic pathways involving biomolecules and the structure-function relationships of proteins.	**PO1, PO2, PO3,PO4**
CO4	**Illustrate** DNA sequencing techniques, principles of NGS, and the biosynthesis of purine and pyrimidine.	**PO1, PO2, PO3, PO4, PO5,PO6**
CO5	**Describe** lipidomics, fatty acid oxidation, and cholesterol biosynthesis in relation to physiological and metabolic events.	**PO1, PO2, PO3, PO4, PO5,PO7**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	1	-	-	-	-	-
CO2	3	3	2	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	2	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	2.6	2.8	2.4	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21502	Biophysical Chemistry & Bioanalytical Techniques (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry				
Co-requisites	--				

Course Objectives

1. To develop the skills of the application of basic and advanced techniques employed in quantitative and qualitative analysis ofbiomolecules.
2. To be able to communicate and discuss the various methods available to purify and characterize biological molecules based on their physical and chemicalproperties.
3. To be able to choose from the various methods available for purifying and characterizing biological molecules based on their physical and chemicalproperties.
4. To provide scientific understanding of analytical techniques and detail interpretation ofresults.

Course Outcomes

On completion of this course, the students will be able to
CO1: Recall the basic principles of membrane biophysics, including membrane structure, function, and dynamics.

CO2: Understand the principles behind chromatographic techniques, including HPLC and GC, and their applications in bioanalysis.

CO3: Apply spectroscopic techniques to study the structure and dynamics of biomolecules such as proteins and nucleic acids.

CO4: Critically evaluate the use of radiolabeling in studying membrane transport processes and cellular interactions.

CO5: Evaluate the strengths and limitations of different spectroscopic techniques in biophysical chemistry research.

Catalogue Description

This course contains bioanalytical techniques along with their theory, working principal, common instrumentation and possible applications. This course will be equally beneficial to various scientific areas including, lifescience, chemical science, material science and environmental science. The information presented in this course will provide the student with valuable insight into the characterization and separation of biological macromolecules. By the end of this course, the student

should be able to choose the correct method or combination of methods to characterize and separate biological macromolecules based on the physical and chemical properties of themolecules.

Course Content

Biophysical Chemistry & Bioanalytical Techniques (BIT21502)

Unit I: Physico-chemical properties of water [6 lecture hours]

Ionic product of water; pH - definition, effect of pH in enzyme catalyzed reaction. Acids, bases and buffers in biological system; Arrhenius, Bronsted-Lowry theories of acid and bases. Polyprotic acids, ampholytes, dissociation of polyprotic acid; titrable and true acidity. Surface tension, viscosity: application tobiomolecules.

Unit II: Thermodynamics and Reaction Kinetics [16 lecturehours]

Thermodynamic state, state functions and thermodynamic systems. 1st and 2nd Laws of Thermodynamics, Concepts of enthalpy, entropy and free energy. Gibb's free energy; Chemical Potential, Chemical Equilibrium. Application of thermodynamics in biological systems; Bioenergetics.

Rates and rate equations of chemical reactions. Standard states, steady states. Activation energies, equilibrium constants. Microscopic reversibility. Fast reactions and transientkinetics.

Unit III: Quantum Chemistry and Centrifugation [7 lecture hours]

Waves, particles and quanta; Electromagnetic spectrum and transition energies. Quantum mechanical postulates, eigenfunction, eigenvalue, Schrodinger equation, particle in box problem, central concepts in spectroscopy. Scattering absorption and dispersion. Principle of centrifugation and different types of centrifuge. Differential & density gradient centrifugation.

Unit IV: Spectroscopic and Chromatographic Techniques [12 lecture hours]

Concept of electromagnetic radiations - UV, visible, IR. Orbital theory: Bonding and antibonding; Absorption and emission spectroscopy of biomolecules: UV-Visible Spectroscopy, Fluorescence Spectroscopy and Energy transfer. TLC, HPLC, HPTLC & FPLC, Size-exclusion Chromatography, Affinity chromatography, Ion- exchange Chromatography.

Unit V: Radioactivity [4 lecture hours]

Radioactive & stable isotopes; Units of radioactivity; Measurement of radioactivity; Measurement of stable isotopes; Falling drop method; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Radioimmunoassay.

Text Books:

1. Biophysical Chemistry by James P. Allen.2008
2. Immunoassay and Other Bioanalytical Techniques by Jeanette M. van Emon,2006

Reference Books:

1. Biochemical Techniques: Theory and Practice by John F. Robyt2015
2. Physical Chemistry for the Life Sciences. Peter Atkins, Julio de Paula by Peter Atkins, Julio de Paula,2011

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall the basic principles of membrane biophysics, including membrane structure, function, and dynamics	PO1, PO2, PO3, PO4
CO2	Understand the principles behind chromatographic techniques, including HPLC and GC, and their applications in bioanalysis.	PO1, PO2, PO4, PO8
CO3	Apply spectroscopic techniques to study the structure and dynamics of biomolecules such as proteins and nucleic acids.	PO1, PO2, PO3, PO4, PO5, PO6,PO7
CO4	Critically evaluate the use of radiolabeling in studying membrane transport processes and cellular interactions.	PO1, PO2, PO3, PO4, PO5, PO7
CO5	Evaluate the strengths and limitations of different spectroscopic techniques in biophysical chemistry research.	PO4, PO5, PO6, PO7, PO8, PO9, PO10

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	1	-	-	-	-	-
CO2	3	3	2	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	2.8	2.8	2.4	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21590	Applied Microbiology	L	T	P	C
Version 1.0	Contact hours-45	3	0	0	3
Pre-requisites/Exposure	B Sc in Basic/Applied Biology				
Co-requisites	-				

Course Objectives

1. To acquire the knowledge about the cell structure and interaction with neighbouring cells in biological system.

2. To gain the knowledge about the dynamics of the cellular motility.

3. To acquire the knowledge about the transport of molecules in different cellular compartments and trafficking of the cellular proteins.

4. To gain the knowledge about pattern of development in plants and animals.

5. To understand the application and significance of different techniques to analyze the cellular differentiation pattern and growth of cancer.

Course Outcomes

On completion of this course, the students will be able to:

CO1: Recall key concepts and facts related to the microbial world, culture and staining techniques, microbial physiology, control of microorganisms, and industrial applications of microbiology.

CO2: Demonstrate a comprehensive understanding of the various techniques used for culturing and staining microorganisms, as well as the physiological processes that occur within microbial cells.

CO3: Apply knowledge of microbial physiology to quantify growth and growth yields of microorganisms.

CO4: Analyze the impact of microbial activities on human health, agriculture, and the environment, as well as critically evaluate the effectiveness of different microbial control strategies.

CO5: Evaluate the significance of microbiology in various industries, including food and beverage production, pharmaceuticals, biofuels, and bioremediation.

Catalogue Description

Applied Microbiology

Cell is the structural and functional unit of living organism, it is well known throughout the universe, but mystery the molecular mechanism for performing the different kinds of functions of cell organelle (along with their development in both plant and animal system) and their integration into a beneficial outcome for living organism different organelle is almost unknown. So the course consists of structure function relationship of cell organelles, trafficking of different molecules between different cellular compartments and their secretion, cross talk between signalling proteins of different

molecular pathway and pattern of the development of living organisms from a single cell.

Course Content

Applied Microbiology

Unit I: Introduction to microbiology [9 hours lecture]
Comparison of prokaryotic and eukaryotic cells, Overview of microbes and their types, Viruses, Bacteria, fungi and protozoans – Morphology and classification. Nutritional requirements of bacteria, physical requirements, Koch's postulates.

Unit II: Microbial Culture & staining techniques [9 hours lecture]
Theory and practice of sterilization, principles of Microbial nutrition: different types of culture media & their preparations, axenic culture, Isolation of pure cultures, maintenance and preservation of the pure cultures, staining techniques, basics of light microscopy.

Unit III: Microbial Physiology [9 hours lecture]
The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; continuous culture; growth as affected environmental factors; enumeration of cells by direct and indirect methods; microbial characterization methods

Unit IV: Control of micro-organisms [9 hours lecture]
Concept of sterilization and disinfection. Physical and chemical methods of microbial control. Chemotherapeutics, susceptibility test (broth procedures and diffusion methods), mode of action of antibiotics, narrow and broad spectrum (Penicillin, ampicillin, sulfonamide, vancomycin, tetracycline, chloramphenicol), antifungals (clotrimazole, fluconazole), antiretroviral (tenofovir, AZT).

Unit V: Industrial applications of microbial technology [9 hours lecture]

Overview of applications of microbial technology in agriculture, healthcare (production of recombinant vaccines), biomining and recovery of petroleum, bioremediation, biofuel production, and waste treatment.

Text Books

1. Karp G. (2010) Cell and Molecular Biology – Concepts and Experiments, 6th Edn. John Wiley and Sons.

2. Glazer, A. N., & Nikaido, H. (2007). Microbial biotechnology: fundamentals of applied microbiology. Cambridge University Press.

3. .Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.

Reference Books

1. Stanbury, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press,Oxford.

2. Casida, L. E. (1968). Industrial microbiology. Industrial microbiology.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Continuous Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Recall key concepts and facts related to the microbial world, culture and staining techniques, microbial physiology, control of microorganisms, and industrial applications of microbiology	PO1, PO2, PO7 PO8
CO2	Demonstrate a comprehensive understanding of the various techniques used for culturing and staining microorganisms, as well as the physiological processes that occur within microbial cells.	PO1, PO2, PO4,PO5 PO6,PO8
CO3	Apply knowledge of microbial physiology to quantify growth and growth yields of microorganisms.	PO1, PO2, PO3,PO4,PO5,PO6, PO7,PO8
CO4	Analyze the impact of microbial activities on human health, agriculture, and the environment, as well as critically evaluate the effectiveness of different microbial control strategies.	PO1, PO2, PO4,PO5 PO6, PO8
CO5	Evaluate the significance of microbiology in various industries, including food and beverage production, pharmaceuticals, biofuels, and bioremediation.	PO1, PO2, PO3,PO4,PO5,PO6, PO7,PO8

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	2	-	-	-	-	-
CO2	3	3	3	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	3	3	3	-	-	-	-	-
Average	3	3	3	2.8	3	2.8	2.6	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21504	Molecular Genetics	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	B SC in Biological Science				
Co-requisites	12th level English				

Course Objectives:

1. To help the students to develop fundamental knowledge in molecular genetics;

2. Describe the ideas running throughout the course on the challenge of integrating various aspects of qualitative and quantitative genetics and insights molecular mechanisms;

3. Describe the ideas running throughout the course on the challenge of integrating biological science and clinical science;

4. At the end of the cohesive teaching, the student should obtain an integrated knowledge of all the areas of classical and modern genetics and will be able to explain the molecular mechanisms behind these all genetical phenomena.

Course Outcomes

On completion of this course, the students will be able to

CO1. Define the physical basis of heredity and genetic interactions

CO2. Explain the mechanisms of non-Mendelian inheritance such as maternal effect, cytoplasmic inheritance, and imprinting, as well as the factors influencing complex trait inheritance like inbreeding and the interaction between genetics and the environment.

CO3. Apply the Hardy-Weinberg equation to calculate allele and genotype frequencies in a population.

CO4. Analyze the implications of using molecular markers in plant breeding programs.

CO5. Evaluate the potential impact of emerging technologies in molecular genetics on society and healthcare.

Catalogue Description

Molecular Genetics is a challenging lecture course that covers a range of basic topics including various branches of genetics like classical, population genetics etc. The course takes a broader approach and covers many aspects of mendelian, non-Mendelian and population genetics. Moreover, this curriculum covers genetical basis of cancer as well bacterial genetics. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapers etc.

Course Content: Molecular Genetics (45hours)

Unit I: Physical basis of Heredity and Genetic interactions: (10 hours)

Unit I: Classical Vs modern genetics: History of genetics, Mendelian principles, monohybrid and dihybrid crosses, dominance, codominance and incomplete dominance, gene interaction and epistasis, concept of gene and cistron, cis-trans complementation experiment, lethal, selfish and pseudogenes, gene concept, structure of genes.

Unit II: Non-Mendelian inheritance: (10 hours)

Maternal Effect; Cytoplasmic inheritance: mitochondria and chloroplasts, Imprinting. Deviation from Mendelism and inheritance of complex trait: Complex patterns of inheritance, quantitative traits, Inbreeding and resemblance between relatives; Genes and environment

Unit III: Hardy-Weinberg equilibrium (10 hours)

Population structure and effective population size; Hardy-Weinberg Equilibrium: Allele and genotype frequency measurements, Random and non-random mating, inbreeding depression and inbreeding co-efficient; causes of changes in allele frequency through natural selection/artificial selection; migration and random genetic drift; equilibrium at sex-linked loci; Linkage and Linkage Disequilibrium

Unit IV: Marker assisted breeding: (7 hours)

Molecular markers as new efficient tools in breeding, marker aided selection – foreground and background selection, concept of graphical genotypes, elimination of linkage drags.

Unit V: Advanced Topics in Molecular Genetics: (8 hours)

Functional Genomics: Transcriptomics, proteomics, and metabolomics; Genome Editing: CRISPR-Cas9 technology, applications, and ethical considerations; Synthetic Biology: Design principles, genetic circuits, and applications.

Text Books

1. Molecular markers in Plant Genetics and Biotechnology, Vienne D – INRA.
2. Modern Genetic Analysis, Griffiths AJF et al., - Freeman.
3. Genetics: Analysis of Genes and Genomes, Hartle DL and Jones EW – Jones and Bartlett.
4. Principles of Genetics by Sinnet et.al (Mc Graw Hill).
5. Principles of Heridity by Robert Tumarin.
6. Genetics by M.W.Strick Berger (Mac Millan).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Define the physical basis of heredity and genetic interactions	**PO1, PO2, PO10**
CO2	Explain the mechanisms of non-Mendelian inheritance such as maternal effect, cytoplasmic inheritance, and imprinting, as well as the factors influencing complex trait inheritance like inbreeding and the interaction between genetics and the environment.	**PO2, PO3, PO6**
CO3	Apply the Hardy-Weinberg equation to calculate allele and genotype frequencies in a population.	**PO2, PO3, PO6**
CO4	Analyze the implications of using molecular markers in plant breeding programs.	**PO1, PO2, PO5**

CO5	Evaluate the potential impact of emerging technologies in molecular genetics on society and healthcare	**PO1, PO2, PO6**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	2	-	-	-	-	-
CO2	3	3	3	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	3	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	2.8	2.8	2.6	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

Course Title	Ecology and Evolution	L	T	P	C
Course Code	BIT21581	3	3	0	3
Contact Hours	15 weeks × 3 hr = 45 hr				
Pre-requisites/Exposure	12th level English + B.Sc Biology discipline				

Course Objectives:

1. Provide students with the scope to develop knowledge base covering all attributes of the environment and enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with duediligence.
2. Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental and ecological concerns of varied dimensions of present times through researchactivities.
3. Provide with a direction and technical capability to carry on collaborative endeavour, and decisionmaking.
4. Help graduates appreciate requirement of framing environmental policy guidelines.
5. Motivate graduates to appreciate that they are an integral stakeholder in the environmental management of India irrespective of their future jobs or working.

Course Outcomes

On completion of this course, the students will be able to

CO1: Explain fundamental concepts in ecology and evolution, including natural selection, species interactions, and ecosystem dynamics.

CO2: Analyze the interactions between organisms and their environment and how these relationships shape evolutionary processes.

CO3: Apply evolutionary theories to understand patterns of adaptation, speciation, and extinction in ecological systems.

CO4: Evaluate the effects of human activities, such as habitat destruction and pollution, on ecological and evolutionary processes.

CO5: Design conservation strategies that integrate evolutionary and ecological principles to promote biodiversity and ecosystem sustainability.

Course Description

This course covers ecological and evolutionary principles on population, community, ecosystem and biodiversity. The very nature of ecology and evolution requires students to view role of evolutionary process on modern human life. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Catalogue Description

Familiarize students with the specific characteristics of a laboratory of analytical biochemistry &biophysical chemistry. To know the analytical methods commonly used in the clinical laboratory. Know how can contribute the clinical laboratory to assess the health status of individuals. At the end of the course the student will know the techniques and applications of molecular biology and biochemistry. Emphasis on current techniques and structure/function relationships of biological macromolecules. This course covers the tools and techniques by which biological molecules are isolated, separated, identified, and analyzed. Detailed discussion of experimental methods for macromolecule purification and characterization isincluded.
The Introductory Biochemistry course covers fundamental biochemical and molecular biological laboratory techniques, supporting concepts, and data analysis. The aims of this course are 1. To provide students with practical knowledge and hands-on experience with some of the most common experimental methods used in biochemical and molecular biological research, and 2. to introduce students to the fundamentals of scientific writing. Methods include reagent preparation, proper use of instrumentation, biochemicalanalysis,

Course Content : Ecology and Evolution (BIT21581)
Unit I: (10 hrs)
A. Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy.
B. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
C. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
Unit II: (10 hrs)
A. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); the concept of metapopulation – demes and dispersal, intergenic extinctions, age-structured populations.
B. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, lotka volterra model.
C. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
D. Ecological succession: Types; mechanisms; changes involved in succession; the concept of climax.

Unit III: (5 h rs)

A. Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, eustarine).

B. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

C. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit IV: (10 hrs)

A. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism, Geological time scale.

B. Sources of variations and Population genetics: Heritable variations and their role in evolution, Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium.

C Natural selection: (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies), Speciation.

Unit V: (10 hrs)

A. Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches).

B. Phylogenetic trees: construction of phylogenetic trees, interpretation of trees

B. Animal Behaviour: Instinctive and learning behaviour, Fixed action pattern, Communication in honeybees (dance Language), Elements of Sociobiology: Altruism and selfishness.

Reference books:

Diversity of Life: The Five Kingdoms by Lynn Margulis, 1992
The Diversity of Living Organisms by Richard Stephen Kent Barnes, 2009
Ecology by Michael L. Cain, William D. Bowman, 2008
Fundamentals of Ecology by Odum and Barrett, 2005
Biodiversity: an introduction by Kevin J. Gaston, 2004

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos

	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Explain fundamental concepts in ecology and evolution, including natural selection, species interactions, and ecosystem dynamics.	PO1, PO2, PO10
CO2	Analyze the interactions between organisms and their environment and how these relationships shape evolutionary processes.	PO1, PO2, PO10
CO3	Apply evolutionary theories to understand patterns of adaptation, speciation, and extinction in ecological systems.	PO1, PO2, PO5, PO6, PO7
CO4	Evaluate the effects of human activities, such as habitat destruction and pollution, on ecological and evolutionary processes.	PO1, PO2, PO8, PO9, PO11, PO12
CO5	Design conservation strategies that integrate evolutionary and ecological principles to promote biodiversity and ecosystem sustainability.	PO1, PO2, PO3, PO8,PO6, PO7

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	1	1	1	1	1	1	1	3	1	1
CO2	3	3	1	1	1	1	1	1	1	3	1	1
CO3	3	3	1	1	3	3	3	1	1	1	1	1
CO4	3	3	1	1	1	1	1	3	3	1	3	3
CO5	3	3	3	1	1	3	3	3	1	1	1	1
Avg	3	3	1.4	1	1.4	1.8	1.8	1.8	1.4	1.8	1.4	1.4

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21536	Bio-Ethics and Intellectual Property Rights (THEORY)	L	T	P	C
Version 1.0	Contact Hours – 75	3	0	0	3
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology and concept of innovation.				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of components and process of obtaining protection usingIPR.
2. It will also discuss various aspects ofbioethics
3. To study the scope of entrepreneurship development using biotechnology and imbibe skills.

Course Outcomes

On completion of this course,

CO1. **Define** the concept of Intellectual Property Rights (IPR) and its significance in the field of biotechnology.

CO2. **Interpret** the provisions of various agreements and treaties governing IPR in the context of biotechnology.

CO3. **Apply** the effectiveness of safety protocols and regulations in ensuring responsible conduct in biotechnology research.

CO4. **Evaluate** and propose bioethical, biosafety and IPR guidelines for research and bio-entrepreneurship activities in the biotechnology sector.

CO5. **Analyze** the ethical dilemmas faced by biotechnologists in balancing innovation and ethical considerations.

Catalogue Description

The core-course of bioethics, IPR and biological patent is a core course that discusses various concepts of IPR along with its background, history and method of obtaining them. This is a fundamental course that would help students to be aware of the legal protection of innovation and innovative products. Several bio-ethical concepts are also discussed to provide critical

appraisal on various biological processes. The scope of entrepreneurship utilizing biotechnological ideas are also dealt in thiscourse.

Course Content

Bio-Ethics and Intellectual Property Rights (BIT21536)

Unit I. Intellectual Property Right (IPR) [10 hrs]

Concept and provisions of IPR Patents, Trademarks, Copyright, Conditional information, Breeder's right. Patent; importance, types, scope, criteria, applying for a patent. Protection of Biotechnological inventions. Patent infringement- meaning, scope, litigation, case studies and examples

Unit II. Agreements and Treaties [5 hrs]

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT

Unit III. Safety in Biotechnology [10 hrs]

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines, Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.

Unit IV. Bioethics [10 hrs]

Biotechnology information, communication and public perception, Future prospects of consumers and social acceptance. Case studies

Unit V Bio-entrepreneurship [10 hrs]

Support mechanism for entrepreneurship in India; Leadership skills; Managerial skills; Team building; teamwork;. Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks. Information technology for business administration, E-business setup and management.

Suggested Books:

1. The Ethics of Biotechnology by Jonathan Morris, 2005
2. Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology by Barry R. Schaller,2007
3. Nexus of Law and Biology: New Ethical Challenges by Barbara Ann Hocking,2009
4. Intellectual Property and Biotechnology: Biological Inventions by Matthew Rimmer,2008
5. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology byPadma Nambisan,2017
6. Biotechnology Entrepreneurship by Craig Shimasaki,2014

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Define** the concept of Intellectual Property Rights (IPR) and its significance in the field of biotechnology.	PO1, PO2, PO3, PO4, PO5, PO8, PO11
CO2	**Interpret** the provisions of various agreements and treaties governing IPR in the context of biotechnology.	PO1, PO6,PO8, PO11
CO3	**Apply** the effectiveness of safety protocols and regulations in ensuring responsible conduct in biotechnology research.	PO1, PO4, PO5, PO6 PO11
CO4	**Evaluate** and propose bioethical, biosafety and IPR guidelines for research and bio-entrepreneurship activities in the biotechnology sector.	PO1, PO4, PO5, PO6, PO8, PO9, PO10, PO11, PO12

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	3	3	3	3	2
CO2	3	3	3	3	2	3	2	2	2	2	3	2
CO3	3	3	2	3	3	3	3	3	2	2	3	3
CO4	3	2	2	3	3	3	3	3	3	3	3	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Average	3	2.6	2.4	2.8	2.6	3	2.8	2.8	2.6	2.6	3	2.6

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

Course Title	Biophysical Chemistry & Bioanalytical Techniques Lab	L	T	P	C
Course Code	BIT22582	0	0	4	2
Contact Hours	15 weeks × 4 hr = 60 hr				
Pre-requisites/Exposure	B.Sc. level Biochemistry				
Co-requisites	-				

Course Objectives

1. To introduce students to experimentation inbiochemistry.
2. To train the students of the subject on handling various experimental methods and techniques in order to analyse the given biological samples from biochemical stand points.
3. The course is designed to teach the utility of these experimental methods in a problem-orientedmanner.
4. To make students familiar with principles of enzyme activity, analysis ofenzyme.

Course Outcomes
On completion of this course, the students will be able to
CO1: **Illustrate** basic concepts of biochemistry through simple experiments.
CO2: **Demonstrate** the use of basic laboratory instruments and explain principles underlying measurements in biochemistry.
CO3: **Apply** quantitative techniques to estimate biomolecules and perform enzyme kinetics.
CO4: **Experiment** with DNA and RNA isolation and manipulation techniques.
CO5: **Elaborate** on the use of various chromatography techniques for protein purification.

Catalogue Description

Bioanalytical chemistry focuses on the sample analysis and not the purification of proteins or the molecular cloning of genes, which are the key components in biochemistry laboratory. Unlike biochemistry, which often focuses on chemical reactions driving biological systems, biophysical chemistry is aimed at the collection and analysis of quantitative data to provide predictive physical models describing biological phenomena occurring at the molecular level.

Course Title: Biophysical Chemistry and Bioanalytical Techniques Lab: BIT22582

Course Content [6 hrs for each experiment]

UNIT I:

1. Demonstration of analytical instruments (principles and applications).
2. Methods of cell breakage.

UNIT II:

3. Estimation of total protein, carbohydrate, DNA and RNA of a bacterial cell.
4. TLC for sugar / lipid / amino acid.

UNIT III:

5. Determination of activity of amylase, protease. Effect of pH, temperature on enzyme activity; Enzyme kinetics.

UNIT IV:

6. Determination of MW of protein byPAGE.
7. Study of enzyme by native gelelectrophoresis.

UNIT V:

8. Demonstration of 2D – gel electrophoresis and Gel documentation system.

Text Books:

1. Practical Physiological Chemistry: A Book Designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science (Classic Reprint) by Philip Bovier Hawk, 2017

Reference Books:

1. Introduction To Practical Biochemistry by Plummer D T ,2006
2. Analytical Biochemistry & Separation Techniques by P. Palanivelu, M. Salihu2009

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Illustrate basic concepts of biochemistry through simple experiments.	PO1, PO2, PO5
CO2	Demonstrate the use of basic laboratory instruments and explain principles underlying measurements in biochemistry.	PO1, PO2, PO4, PO5, PO6
CO3	Apply quantitative techniques to estimate biomolecules and perform enzyme kinetics.	PO1, PO3, PO4, PO5, PO6, PO7
CO4	Experiment with DNA and RNA isolation and manipulation techniques.	PO1, PO3, PO4, PO5, PO6, PO7, PO9, PO11
CO5	Elaborate on the use of various chromatography techniques for protein purification.	PO1, PO2, PO3, PO4, PO5, PO8, PO10

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	1	-	-	-	-	-
CO2	3	3	3	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	3	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	3	2.8	2.4	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22531	Applied Microbiology and Molecular Genetics Lab	L	T	P	C
Version 1.0	Contact Hours - 60	0	0	4	2
Pre-requisites/Exposure	GRADUATION LEVEL KNOWLEDGE OF CELL BIOLOGY AND MICROBIOLOGY				
Co-requisites	--				

Course Objectives:

1. To provide students with hands-on activities designed to encourage interest in the field of cell and developmental biology.
2. Students will need to become proficient with terms, techniques, and applications.

Course Outcomes

On completion of this course, the students will be able to:
CO1.Recall and identify the various culture methods used in microbiology for growing and isolating microorganisms.

CO2. Explain the principles and importance of staining techniques such as Gram staining, acid-fast staining, and endospore staining in microbiological identification.

CO3. Demonstrate the ability to perform and interpret biochemical tests, such as catalase, oxidase, and sugar fermentation tests, for the identification of unknown microorganisms.

CO4. Analyze and interpret the results of minimum inhibitory concentration (MIC) tests to determine the sensitivity of microorganisms to antimicrobial agents.

CO5. Critically evaluate the relationship between chromosome structure aberrations and genetic diseases.

Catalogue Description

APPLIED MICROBIOLOGY & MOLECULAR GENETICS LAB intends to train students on the basic techniques in microbiology and molecular genetics. The students will be divided into small groups so as to enable maximum the acquisition of optimal hands-on experience. The experimental sessions will equip the students with real-life problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

1.	Aseptic techniques and Media preparation (Both liquid and solid)	**6 Hour**
2.	Isolation and enumeration of bacteria from different sources by serial dilution agar plating method	**6 Hour**
3.	Staining of bacteria (Simple staining, negative staining, gram staining, etc.)	**6 Hour**
4.	Biochemical tests of bacteria (Starch hydrolysis, casein hydrolysis, IMVIC test, catalase activity)	**6 Hour**
5.	Antibiotic sensitivity test of different microbial isolates	**6 Hour**
6.	Determination of Minimum Inhibitory Concentration of different antibiotics	**6 Hour**
7.	Visualization and analysis of chromosome structure and aberrations	**6 Hour**
8.	Demonstration and hands-on practice of hybridization	**6 Hour**
9.	Goodness of fit test using Mendelian Genetics concept	**6 Hour**
10.	Determination of gender from buccal smear by identification of Barr bodies	**6 Hour**

Reference Books

- Microbiology: A Laboratory Manual, Book by James G. Cappuccino and Natalie Sherman
- Cell Biology: A Laboratory Handbook by J E Celis, 2016

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall and identify the various culture methods used in microbiology for growing and isolating microorganisms.	PO1,PO5, PO7

CO2	Explain the principles and importance of staining techniques such as Gram staining, acid-fast staining, and endospore staining in microbiological identification.	PO1,PO2
CO3	Demonstrate the ability to perform and interpret biochemical tests, such as catalase, oxidase, and sugar fermentation tests, for the identification of unknown microorganisms.	PO1,PO6
CO4	Analyze and interpret the results of minimum inhibitory concentration (MIC) tests to determine the sensitivity of microorganisms to antimicrobial agents.	PO1, PO2, PO3, PO5, PO6,PO7,
CO5	Critically evaluate the relationship between chromosome structure aberrations and genetic diseases.	PO1, PO2, PO3,PO4,

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	2	-	-	-	-	-
CO2	3	3	3	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	3	3	3	-	-	-	-	-
Average	3	3	2.8	2.8	3	2.8	2.6	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22533	Professional Development Course-1 (Practical)	L	T	P	C
Version 1.0	Contact Hours - 15	0	0	1	1
Pre-requisites/Exposure	PLUS B.SC LEVEL SCIENCE				
Co-requisites	--				

Catalog Description: This personal development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 1st Semester- 3rd Semester for P.G students)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1. Demonstrate knowledge of creating an effective CV tailored to specific job requirements

CO2. Interpret feedback on CVs and improve them accordingly

CO3. Practice aptitude tests to improve speed and accuracy

CO4. Analyze the relevance of technical skills in the current job market

CO5. Create a professional CV, cover letter, and portfolio for job applications

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Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	2	1	3	-	-	-	3
CO2	3	3	3	3	3	3	2	3	-	-	-	3
CO3	3	3	3	3	3	3	3	3	-	-	-	3
CO4	3	3	3	3	3	3	3	3	-	-	-	3
CO5	3	3	3	3	3	3	3	3	-	-	-	3
Average	3	3	2.8	3	2.8	2.8	2.4	3	-	-	-	3

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

ADAMAS UNIVERSITY
SEMESTER - II

BIT21509	MOLECULAR BIOLOGY	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	Basic Knowledge of Life Science.				
Co-requisites	--				

Course Objectives

1. Understand the basic concepts ofgenetic.
2. Students understand how molecular biology techniques can and are being applied to study almost every area of biochemistry and biology and driving whole genomestudies.
3. Know the basic concept of the "central dogma" and themechanisms.
4. Outlining the relation between Transcription and Post TranscriptionalModifications.

Course Outcomes

On completion of this course, the students will be able to

CO1: Identify the structural complexity of genomes, including the C-value paradox, repetitive DNA, and satellite DNA, along with the organization of genes, nucleosomes, and DNA methylation.

CO2: Explain the models and enzymes involved in DNA replication, repair mechanisms, and phage strategies.

CO3: Analyze the transcription machinery components and regulation in prokaryotes and eukaryotes.

CO4: Understand the translation processes, post-translational modifications, and regulation of gene expression through operons and transcriptional control.

CO5: Investigate protein trafficking mechanisms, antisense and ribozyme technologies, and genome mapping techniques.

Catalogue Description

This course unit aims to delve into the intricate mechanisms underlying protein trafficking and signal transduction pathways pivotal in regulating the cell cycle and influencing cancer genetics. Students will explore how proteins are transported, localized, and recycled within cells, understanding their roles in maintaining cellular homeostasis and responding to external signals. Additionally, they will examine the disruptive alterations in these pathways that contribute to cancer development and

progression. Furthermore, students will analyze the innovative technologies of antisense and ribozymes, unraveling their molecular mechanisms and applications in targeted gene manipulation and disruption. Moreover, they will explore genome mapping techniques, encompassing genetic and physical mapping, to elucidate gene localization and analyze genomes, providing valuable insights into the genetic underpinnings of various traits and disorders.

Course Content

Molecular Biology (BIT21509)

Unit I: Genome organization (10 hr)

Genetic organization of Prokaryotes and Eukaryotes including nuclear genome and organelle genome; DNA as the genetic material (Experimental evidences); Central dogma; Genome complexity; C-value paradox, Cot value, Repetitive DNA, Satellite DNA; Gene structure in Prokaryotes and Eukaryotes; Cistron, Recon, Muton; split genes, pseudogenes, clusters and repeats. Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting. Structure of DNA - A-,B-, Z- and triplex DNA.

Unit II: DNA Replication and Repair (10 hr)

DNA replication: Models of DNA replication, Enzymes of DNA replication, Process of DNA replication (initiation, elongation, termination), DNA replication at the telomere; DNA recombination (site specific and homologous); Inhibitors of Replication; DNA repair (base-excision, mis-match, SOS, recombination); Recombination and transposition at the molecular level: Homologous recombination, double-strand break–repair model, gene conversion, site-specific recombination - Mechanism and biological roles.

Unit III: Transcription and post transcriptional modicfication (10 hr)

Transcription: Components of transcription machinery in Prokaryotes and Eukaryotes, Trancriptional factors, Transcription process (initiation, elongation and termination); Posttranscriptional processing, Regulation of transcription (protein-DNA interaction: zinc finger motif, homeodomain, helix-loop-helix, leucine zipper), m-RNA stability, m-RNA editing; Nuclear splicing, Catalytic RNA, Mechanism of gene silencing. Inhibitors for Transcriptional process.

Unit IV: Translation and post translational modification (7 hr)

; Translation: Genetic Code- Principle of translation, Translation machinery in Prokaryotes and Eukaryotes (t-RNA, Aminoacyl synthetase, Ribosome), Translation process (initiation, elongation and termination). Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; translational Inhibitors; Regulation of gene expression in Prokaryotes and Eukaryotes; Operon concept (Lac, Ara, Trp and His).

Unit V: Molecular Mechanisms and Mapping in Cellular Regulation (8 hr)

Protein trafficking (glycosylation, coated vesicles, budding and fusion reactions, protein localization, receptor recycle), Signal transduction (carriers and channels, G protein mediated, Ras/MAPK pathway, MAP kinase pathway, cAMP mediated, JAK-STAT pathway), Cell cycle and its regulation, Genetics of cancer (Proto-Oncogenes, Tumor Suppressor genes), Signaling pathways.

Suggested Books:

1. Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan)
2. Genes VIII by B.Lewin (Oxford)
3. Cell and Molecular Biology by E,D.P.De Roberties (International edition)
4. Molecular Biology by David Frefielder.
5. DNA Science by Carolina Publishing Company.
6. Molecular Biology of the Gene by J.D.Watson et. Al.,(Benjamin).
7. RNAi-Design and application by Basic (Springer).
8. Small RNAs-Analysis and Regulatory functions by Nellen (Springer).

Reference books:

1. Molecular Cell Biology by Harvey Lodish, 2003.
2. Genetic analysis and principles by R. J. Brooker, Mc Graw-Hill, 4th edition, New York, 2012.
3. Molecular Biology; Genes to protein by Burton E. Tropp, Jones and Batrlett, 4th edition, USA

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Mapping between Cos and Pos		
	Course Outcomes (Cos)	**Mapped Program Outcomes**
CO1	Identify the structural complexity of genomes, including the C-value paradox, repetitive DNA, and satellite DNA, along with the organization of genes, nucleosomes, and DNA methylation.	PO1, PO2
CO2	Explain the models and enzymes involved in DNA replication, repair mechanisms, and phage strategies.	PO1, PO2, PO3
CO3	Analyze the transcription machinery components and regulation in prokaryotes and eukaryotes.	PO1, PO2, PO4
CO4	Understand the translation processes, post-translational modifications, and regulation of gene expression through operons and transcriptional control.	PO1, PO2, PO4, PO5, PO6
CO5	Investigate protein trafficking mechanisms, antisense and ribozyme technologies, and genome mapping techniques.	PO1, PO2, PO4, PO5, PO7

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	-	-	-	-	3
CO2	3	3	3	3	3	3	2	-	-	-	-	3
CO3	3	3	3	3	3	3	3	-	-	-	-	3
CO4	3	3	3	3	3	3	3	-	-	-	-	3
CO5	3	3	3	3	3	3	3	-	-	-	-	3
Average	3	3	2.8	3	3	2.8	2.6	-	-	-	-	3

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

Course Title	Advanced Recombinant DNA Technology	L	T	P	C
Course Code	BIT21510	3	0	0	3
Contact Hours	45				
Pre-requisites/Exposure	12th level English + B.Sc Biology discipline				

Course Objectives

1. To provide advanced concepts of Recombinant DNATechnology.
2. Elaborating genetic engineering in plants, gene editing in human, and overexpression of recombinant proteins, cutting-edge sequencing technologies and theirapplications.

Course Outcomes

On completion of this course, the students will be able to

CO1 Recall the basic principles of recombinant DNA technology, including the techniques used for gene cloning and manipulation.

CO2 Understand the process of recombinant DNA technology, including the applications and implications of gene cloning in various fields such as medicine, agriculture, and biotechnology.

CO3 Apply the techniques of recombinant DNA technology to design and conduct experiments related to gene cloning and genetic engineering.

CO4 Analyze the advantages and limitations of recombinant DNA technology in the context of scientific research and biotechnological applications.

CO5 Develop novel strategies and approaches for the advancement of recombinant DNA technology, and propose innovative solutions to biological challenges using genetic engineering techniques.

Catalogue Description:
In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA and proteins. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours. The students will gain an in depth understanding of this important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content

Advanced Recombinant DNA Technology (BIT21510)

Unit I: Basics of DNAcloning (10hrs)
Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones. Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes. Isolation and purification of DNA. RFLP analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis.

Unit II: PolymeraseChainReaction (5hrs)
Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PRC, Vectorette PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology.

Unit III: Construction of cDNA and genomicDNAlibraries (5hrs)
Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

UNIT IV: Transcriptional analysis of gene expression and transcriptomics (10 hrs)
Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. 5' RACE. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expression (SAGE).

Unit V: Overexpression ofrecombinantproteins (15hrs)

Overexpression and tagging of recombinant proteins in *E.coli*, driven by lac, T7 and Tet-regulated promoters, Expression in *B. subtilis*. Overexpression systems in *S.cerevisiae*, *P.pastoris,S.pombe* and *K.lactis*. Baculovirus overexpression system. Mammalian cell overexpression system.

DNA foot printing by DNase I and chemical methods, yeast one-hybrid assay, ChIP- chips. Yeast two hybrids, three-hybrids, split hybrids and reverse hybrids. Co-immunoprecipitations, pull-downs and Far- Westerns. GFP and FRET. Phage display, CRISPER-CAS9, Introduction to metabolic engineering, Systems biology and synthetic biology concepts

Books & Other Resources

Text Book(s)

Text Book:

1. From genes to genomes concepts and applications of DNA technology by Jeremy Wdale and Malcolm von Scrantz, 2011
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard Glick2009

Reference Book:

1. Genomes 3 by T.A. Brown,2006
2. Principles of Gene Manipulation and Genomics by Sandy Primrose and Twyman,2006

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall the basic principles of recombinant DNA technology, including the techniques used for gene cloning and manipulation.	PO1, PO2
CO2	Understand the process of recombinant DNA technology, including the applications and implications of gene cloning in various fields such as medicine, agriculture, and biotechnology.	PO1, PO2,PO3
CO3	Apply the techniques of recombinant DNA technology to design and conduct experiments related to gene cloning and genetic engineering.	PO1, PO2, PO3, PO4

CO4	Analyze the advantages and limitations of recombinant DNA technology in the context of scientific research and biotechnological applications.	PO1, PO2, PO5, PO6, PO7, PO8
CO5	Develop novel strategies and approaches for the advancement of recombinant DNA technology, and propose innovative solutions to biological challenges using genetic engineering techniques.	PO1, PO2, PO3, PO5, PO8, PO11

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	-	-	-	-	3
CO2	3	3	3	3	3	3	2	-	-	-	-	3
CO3	3	3	3	3	3	3	3	-	-	-	-	3
CO4	3	3	3	3	3	3	3	-	-	-	-	3
CO5	3	3	3	3	3	3	3	-	-	-	-	3
Average	3	3	2.8	3	3	2.8	2.6	-	-	-	-	3

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21591	Applied Genomics and Proteomics	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	Basic knowledge of Genomics and Proteomics at UG level				
Co-requisites	--				

Course Objectives:

1. The course will provide an advanced knowledge of genomics and proteomics
2. The course will give an in-depth knowledge about the application areas of genomics and proteomics, with a focus on the recent advancement in this area

Course outcome:

The students will be able

CO1. Identify different genome sequencing techniques

CO2. Interpret genomic data and its significance in various research fields

CO3. Utilize proteomic analysis methods to study protein expression patterns

CO4. Critically evaluate mass spectroscopy data for protein identification and characterization

CO5. Critically evaluate the reliability of proteomic analysis results for biomarker discovery

Course Description:

The main aim of this module is to provide an understanding about the genomics and proteomics techniques and their applications in biological sciences. The subject deals with a rapidly evolving scientific area that introduces students into genomes, proteomes and their databases that store various data about genes, proteins, genomes and proteomes. Students would learn about genomics, proteomics, and offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications. Students would gain skills in comparative, evolutionary, human genomics and functional genomics. The acquired knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories as well as in their postgraduate studies.

Course Content: Applied Genomics and Proteomics (BIT21591)

Unit I

Genome sequencing and analysis

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage, and Pedigree analysis-physical and genetic mapping.

Unit II

Comparative genomics

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

Pharmacogenomics vs pharmacogenetics

Basic concept, difference; One drug fit all – concept, personalized medicine approach and its potential, identification of drug target based on genome-wide screening; Identification of drug target based on functional variants – pharmacogenetics approach; drug response

Unit IV

Proteomics analysis

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing);2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions.

Unit V

Proteome microarray technologies

Analysis of microarray data; Protein and peptide microarray-based technology; Yest two-hybrid system, PCR-directed protein *in situ* arrays; Structural proteomics – basic concept and application

Suggested Books:

1. Sukanta Mondal and Ram Lakhan Singh, Advances in Animal Genomics. 2020. Elesvier
2. Jeremy Dale, Malcolm von Schantz, Nick Plant, From genes to genomes. Concepts and applications of DNA technology. 2020. Wiley Blackwell
3. Gary Walsh, Proteins: Biochemistry and Biotechnology. 2014. Wiley Blackwell
4. Richard Twyman, Principles of Proteomics. 2013 Garland Science; 2nd edition

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam **Examination Scheme:**

Components	**Continuous assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify different genome sequencing techniques	PO1, PO2, PO6
CO2	Interpret genomic data and its significance in various research fields	PO1, PO2, PO3

CO3	Utilize proteomic analysis methods to study protein expression patterns	PO1, PO2, PO5, PO6
CO4	Critically evaluate mass spectroscopy data for protein identification and characterization	PO1, PO2,PO3, PO4, PO5, PO6
CO5	Critically evaluate the reliability of proteomic analysis results for biomarker discovery	PO1, PO2, PO3, PO5, PO6

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	-	-	-	-	-
CO2	3	3	2	3	3	3	3	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-
CO5	3	3	3	3	2	3	3	-	-	-	-	-
Average	3	3	2.8	3	2.8	3	3	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21585	Bioinformatics and Biostatistics (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with apt introductory level knowledge to Biostatistics, Bioinformatics & ComputerApplications.
2. It will also provide in depth knowledge ofbiostatistics.
3. Elaborating the database and biologicaldatabase
4. Explore the knowledge of modern methods of Bioinformatics such as Microarray experiment, Clustering of microarray data, Principal componentanalysis,.

Course Outcomes

On completion of this course, the students will be able to

CO1: Describe biostatistics techniques.
CO2: Illustrate the biological databases and their role in bioinformatics.
CO3: Analyze the knowledge of cluster analysis, phylogenetic clustering, and sequence comparison.
CO4: Explain modern methods of bioinformatics such as microarray experiments, clustering of microarray data, and principal component analysis.
CO5: Apply structure-based bioinformatics, protein structure prediction through homology modeling, and examine current research activities in biostatistics and bioinformatics.

Catalogue Description

The core-course of 'Biostatistics, Bioinformatics & Computer Applications' will help to understand the introductory level knowledge to biostatistics, bioinformatics & computer applications. This course is a beginning to the biostatistics, the application of different bioinformatics methods to biological data analysis, biological database and some current research activities in the field of bioinformatics. Furthermore, the possible applications of this knowledge in biostatistics, bioinformatics & computer applications would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with thecoordinator.

Course Content

Bioinformatics and Biostatistics (BIT21585)

Unit I [10 hrs]

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probabilityand analysis of one and two way samples; discrete and continuous probability models; Expectation andvariance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests forproportion; Equality of proportions; equality of means of normal populations(variance known, varianceunknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to oneway and two-way analysis of variance; Data transformations.

Unit II [10hrs]

Elements of programming languages - C and PERL; Data base concept; Database management system;Database browsing and Data retrieval; Sequence database and genome database; Data Structures andDatabases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR;PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III [8 hrs]

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequencepattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markovmodels; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods. Overview of artificial intelligence, machine-learning, and deep learning.

Unit IV [7 hrs]

Goals of a Microarray experiment; Normalization of Miroarray data; Detecting differential gene expression;Principal component analysis; Clustering of microarray data; Structure determination by X-raycrystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); Fileformats for storage and dissemination of molecular structure.

Unit V [10 hrs]

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structurecomparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; MonteCarlo and molecular dynamics simulationGraphical tools in EXCEL for presentation of data. Introduction to SYSTATpackage.Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequencemanipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling,Protein structure Analysis, Docking, Ligplot interactions.

Suggested Books:

1. Bioinformatics – D.Mount
2. Programming in C by Balaguru Swamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Biostatistics – Daniel. (Wiley).
5. Statistics by S.C.Gupta.
6. Statistical Methods by G.W.Snedecor&W.G.Cochran.
7. Fundamentals of Biostatistics – Khan & Khanum.
8. Let us C – Kanetkar.
9. Fundamentals of Biostatistics by U.B.Rastogi (Ame Books Ltd).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination **Examination Scheme:**

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Describe biostatistics techniques.	PO1, PO2
CO2	Illustrate the biological databases and their role in bioinformatics.	PO1, PO2,PO3
CO3	Analyze the knowledge of cluster analysis, phylogenetic clustering, and sequence comparison.	PO1, PO2, PO3
CO4	Explain modern methods of bioinformatics such as microarray experiments, clustering of microarray data, and principal component analysis.	PO1, PO2, PO5, PO6
CO5	Apply structure-based bioinformatics, protein structure prediction through homology modeling, and examine current research activities in biostatistics and bioinformatics.	PO1, PO2, PO3, PO5, PO8

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	-	-	-	-	3
CO2	3	3	3	3	3	3	2	-	-	-	-	3
CO3	3	3	3	3	3	3	3	-	-	-	-	3
CO4	3	3	3	3	3	3	3	-	-	-	-	3
CO5	3	3	3	3	3	3	3	-	-	-	-	3
Average	3	3	2.8	3	3	2.8	2.6	-	-	-	-	3

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

Course Title	Molecular Biology and Recombinant DNA Technology Lab	L	T	P	C
Course Code	BIT22586	0	0	4	2
Contact Hours	60				
Pre-requisites/Exposure	12th level English + B.Sc. Biology discipline				

Course Objectives

1. To provide basic concepts of buffer preparation to be used for differentpractical.
2. To provide advanced concepts of Molecular biologytechniques.
3. Elaborating protein and nucleic acids isolation and quantification.

Course Outcomes

On completion of this course, the students will be able to

CO1	Define the process of isolating DNA from various sources.
CO2	Demonstrate the process of RNA isolation.
CO3	Illustrate and perform competent cell preparation, transformation, and plasmid DNA isolation.
CO4	Compare and contrast various blotting techniques.
CO5	Develop skills to establish a career in clinical and forensic research labs, agriculture, pharmaceutical, and biotechnology industries.

Catalogue Description:
In classroom sessions students will study the theoretical and applied aspects of basic biotechnology techniques for the study of DNA and proteins. In the laboratory students will apply theory and practical skills from this and previous courses to perform standard molecular biology techniques for the isolation, manipulation and analysis of DNA as well as the expression and purification of protein. Students will be assisted in career development through instruction and practice in resume-writing and interview skills, and will be exposed to different biotechnology job possibilities via a number of special interest seminars and/or company tours. The students will gain an in depth understanding of this important techniques in order to design an analytical work-flow to acquire data and achieve the research objectives of their project.

Course Content

Molecular Biology and Recombinant DNA Technology Lab (BIT22586)

UNIT I:

1. a. Preparation of buffers, reagents and media, etc.; b. Laboratory equipment handling and safety guidelines.

UNIT II:

2. Isolation and characterization of genomic DNA for *E.Coli*, Isolation and characterization of genomic DNA for plant parts.
3. Restriction digestion analysis by agarose gel electrophoresis.

UNIT III:

4. Competent cell preparation, transformation, and plasmid DNA isolation.

UNIT IV:

5. PCR; a. Setting up PCR reaction; b. Analysis of amplified product

UNIT V:

Demonstration of DNA sequencing; a. Setting up sequencing reactions; b. Casting sequencing gel; c. Gel electrophoresis & autoradiography. d. Reading sequencing from X-ray film

Suggested Books:

1. Biotechnology: A laboratory course by Becker J.M.
2. Molecular Cloning : A laboratory manual Vols. 1-3, Sambrook, J.
3. Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern Limited).
4. Biochemistry – A lab course by J.M.Becker (Academic Press).

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam **Examination Scheme:**

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Define the process of isolating DNA from various sources.	PO1, PO2
CO2	Demonstrate the process of RNA isolation.	PO1, PO2,PO3
CO3	Illustrate and perform competent cell preparation, transformation, and plasmid DNA isolation.	PO1, PO2, PO3, PO4
CO4	Compare and contrast various blotting techniques.	PO1, PO2, PO5, PO6, PO7, PO8
CO5	Develop skills to establish a career in clinical and forensic research labs, agriculture, pharmaceutical, and biotechnology industries.	PO1, PO2, PO3, PO5, PO8, PO12

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	0	0	0	0	3
CO2	3	3	3	3	3	3	2	0	0	0	0	3
CO3	3	3	3	3	3	3	3	0	0	0	0	3
CO4	3	3	3	3	3	3	3	0	0	0	0	3
CO5	3	3	3	3	3	3	3	0	0	0	0	3
Average	3	3	2.8	3	3	2.8	2.6	0	0	0	0	3

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22532	Applied Genomics and Proteomics Lab	L	T	P	C
Version 1.0	Contact Hours - 60	0	0	4	2
Pre-requisites/Exposure	UG level knowledge of Genomics and Proteomics analysis skills				
Co-requisites	--				

Course Objectives:

1. The objectives of this course is to provide experimental skills concerning genomics, proteomics and their applications in bioscience today.
2. The course will give an overview about the basic-to-advanced techniques and different softwares used in areas of genomics and proteomics for their applications in current areas of research.

Course outcome:

The students will be able

CO1: Apply the NCBI genome database and dbSNP for genomic and SNP data analysis.

CO2: Annotate ORF regions from sequenced genomes and analyze gene-phenotype relationships using the OMIM browser.

CO3: Predict subcellular localization of proteins using SIGNAL IP tools and demonstrate 2D PAGE techniques.

CO4: Interpret MALDI data from 2D PAGE spots and identify putative motifs and domains in unknown protein sequences.

CO5: Analyze protein structure using PYMOL software and explore protein networks using the String database.

Course Description:

The main aim of this module is to provide an understanding about the genomics and proteomics techniques and their applications in biological sciences. The subject deals with a rapidly evolving scientific area that introduces students into genomes, proteomes, databases that store various data about genes, proteins, genomes and proteomes. Students would learn about the application and analysis of genomics and proteomics databases and corresponding tools which are required for the research purpose at advanced level.

Course Content: **Applied Genomics and Proteomics Lab (BIT22532)**

1. Application of NCBI genome database
2. Application of dbSNP and analysis of data
3. Annotation of ORF region from already sequenced genomes
4. Gene-phenotype relation analysis using OMIM browser
5. Subcellular localization prediction of protein using SIGNAL IP tools
6. Demonstration of 2D PAGE
7. Analysis of MALDI data from 2D PAGE spots
8. Identification of putative motif/s and domain/s from given unknown protein sequence
9. Analysis of physicochemical characteristics of a protein from given unknown amino acid sequence
10. Analysis of protein structure using PYMOL software
11. Use of String database – a basic learning toward protein network biology

Suggested Books:

1. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics.
2. Malden, MA: Blackwell Pub. 2. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology.
3. Totowa, NJ: Humana Press. 3. Campbell, A. M., &Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings. 4. Bionanotechnology by David S. Goodsell, 2004, Wiley Publications

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Apply the NCBI genome database and dbSNP for genomic and SNP data analysis.	PO1, PO2
CO2	Annotate ORF regions from sequenced genomes and analyze gene-phenotype relationships using the OMIM browser.	PO1, PO2, PO3

CO3	Predict subcellular localization of proteins using SIGNAL IP tools and demonstrate 2D PAGE techniques.	PO1-4
CO4	Interpret MALDI data from 2D PAGE spots and identify putative motifs and domains in unknown protein sequences.	PO1, PO4, PO6
CO5	Analyze protein structure using PYMOL software and explore protein networks using the String database.	PO1, PO4, PO5, PO6

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	-	-	-	-	-
CO2	3	2	3	3	3	3	2	-	-	-	-	-
CO3	3	3	3	2	3	3	3	-	-	-	-	-
CO4	3	3	3	3	2	3	3	-	-	-	-	-
CO5	3	3	3	3	3	3	2	-	-	-	-	-
Average	3	2.8	3	2.8	2.8	3	2.2	-	-	-	-	-

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22516	Bioinformatics Lab	L	T	P	C
Version 1.0	Contact Hours - 60	0	0	3	2
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide students with hands-on activities designed to encourage interest in the field of Bioinformatics, as well as promote greater understanding of the concepts presented inlecture.
2. Students will need to become proficient with terms, techniques, andapplications.

Course Outcomes

On completion of this course, the students will be able to

CO1: Identify genes and genomes, and annotate genes.
CO2: Describe the process of sequence alignment for DNA and proteins.
CO3: Apply basic programming using Python.
CO4: Analyze protein structure-function relationships and phylogenetic trees.
CO5: Evaluate the use of modern bioinformatics tools and techniques for academic development.

Catalogue Description

Bioinformatics Lab (Practical) is the overall Learn and apply the knowledge of using different modern tools and techniques in the field of Bioinformatics. This course covers laboratory techniques describes different modern practical methods related to Bioinformatics such as genes and genomes, sequence alignment of DNA and proteins, basic programming using python, predict protein structure-function and phylogenetic tree. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content Bioinformatics Lab (BIT22516) [12 hrs. each experiment]

1. Retrieving genomes, identifying of and annotatinggenes
2. Sequence Alignment of DNA andProteins.
2. Applying UNIX, basic programming usingpython:
3. Predicting proteinstructure-function
4. Building phylogenetictree
5. Protein structure- homology modelling anddocking.

Suggested reading:

1. Essentials of Bioinformatics, Xin Xiong,Cambridge
2. Bioinformatics: Sequence and Genome Analysis by David W. Mount,2004.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify genes and genomes, and annotate genes.	PO1, PO2, PO3
CO2	Describe the process of sequence alignment for DNA and proteins.	PO1, PO10, PO11
CO3	Apply basic programming using Python.	PO1, PO2, PO3, PO4, PO8
CO4	Analyze protein structure-function relationships and phylogenetic trees.	PO1, PO3. PO6, PO9
CO5	Evaluate the use of modern bioinformatics tools and techniques for academic development	PO1, PO4, PO8, PO12

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	3	2	2	3	0	0	0	0	0	0	0
CO3	2	3	3	2	3	0	0	0	0	0	0	0
CO4	3	3	2	3	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	2.8	3	2.4	2.4	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21517	DSE-I CANCER BIOLOGY(THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	B.Sc. LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. Students will understand the structures and purposes of basic carcinogenic components especially organic and inorganic carcinogens
2. Students will understand how cancer cells sabotage the normal metabolomics of a healthy cell and these cellular components are used to generate and utilize energy in cells
3. Students will understand the cellular components underlying cell division and molecular basis of carcinogenesis
4. Students will apply their knowledge of cancer biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

Course Outcomes

On completion of this course, the students will be able to:

CO1: Explain the anomalies in the cell cycle that lead to the onset of cancer and describe various types of cancers.
CO2: Interpret the genetic alterations that contribute to cancer development.
CO3: Identify the unique hallmark abilities of cancer cells.
CO4: Summarize the mechanisms of carcinogenesis.
CO5: Understand various diagnostic techniques and the mechanisms of action of chemotherapeutic and chemopreventive drugs.

Catalogue Description

The core-course of 'Cancer Biology' will help to understand the classification, structure and function of different carcinogenic compounds affecting animals. This course includes comprehensive approach through studying molecular mechanism of carcinogenesis, onset and progression of cancer in humans. It also includes the role of virus as carcinogenic agents. Furthermore, the application of virus and other carcinogens in carcinogenesis, therapeutics and gene delivery would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with thecoordinator.

Course Content

Cancer Biology (BIT21517)

Unit I: Fundamentals of cancer biology (7 hrs)

Cell signaling; Apoptosis; Regulation of Cell cycle; Modulation of cell cycle in cancer; Cancer-basic terminology; Neoplasia; Nomenclature of different forms of cancers.

Unit II: Mutations, Oncogenes, and Tumor suppressor genes (7 hrs)

Nonsense, missense and point mutations, Frameshift mutations; Activation of oncogenes and dominant negative effect; Oncogenes as transcriptional activators; Viral oncogenes; Suppression of tumor suppressor genes; Tumor suppressor genes from humans: Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

Unit III: Hallmarks of cancer (7 hrs)

Self-sufficiency in growth signals; Evasion of growth-inhibitory signals; Limitless replicative potential; Reprogramming of energy metabolism; Evasion of apoptosis; Angiogenesis; Invasion and metastasis; Tumor immunity.

Unit IV: Principles of carcinogenesis (7 hrs)

Physical, chemical and biological mutagens/ carcinogens; Chemical Carcinogenesis, Targets of Chemical Carcinogens, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation carcinogenesis; Mechanisms of viral carcinogenesis.

Unit V: Cancer diagnosis and treatment modalities (7 hrs)

Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.

Textbook:

1. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics by Lauren Pecorino,2016
2. The Biology of Cancer by Robert A. Weinberg,2006

Reference book:

1. Introduction to the Cellular and Molecular Biology of Cancer by Margaret A. Knowles,2005
2. Molecular Biology of the Cell by Bruce Alberts, 6th Ed., 2008.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Explain** the anomalies in the cell cycle that lead to the onset of cancer and describe various types of cancers.	**PO1, PO2, PO3**
CO2	**Interpret** the genetic alterations that contribute to cancer development.	**PO1, PO2,PO5**
CO3	**Identify** the unique hallmark abilities of cancer cells.	**PO1, PO2, PO3, PO4**
CO4	**Summarize** the mechanisms of carcinogenesis.	**PO4, PO6**
CO5	**Understand** various diagnostic techniques and the mechanisms of action of chemotherapeutic and chemopreventive drugs.	**PO3, PO5, PO7, PO8, PO12**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	2	3	3	0	0	0	0	0	0	0
CO4	3	3	3	3	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	3	2.6	3	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21518	DSE-I Human Physiology	L	T	P	C
Version 1.0	**Contact hours-45**	3	0	0	3
Pre-requisites/Exposure	Knowledge of Biology or Applied biology of B.Sc. level				
Co-requisites	-				

Course Objectives

1. To gain a deeper understanding about the organization of buffering system of body fluid.
2. To acquire the knowledge anatomical and physiological organization of respiratory and circulatory system of humanbody.
3. To acquire the knowledge about the biochemical basis of fooddigestion.
4. To gain the knowledge about biochemical basis of kidneyfunction.
5. To understand the biochemical properties of the excitable and endocrinetissue.

Course Outcomes

On completion of this course, the students will be able to

CO1: Recall the major systems of the human body and their functions.
CO2: Explain the mechanisms involved in the physiological processes of the human body.
CO3: Apply knowledge of human physiology to analyze and solve physiological problems.
CO4: Evaluate the impacts of environmental factors on human physiology.
CO5: Assess the ethical implications of medical advancements in human physiology

CatalogueDescription

Physiology is the scientific study of functions and mechanisms in a living system. As a sub-discipline of biology, physiology focuses on how organisms, organ systems, individual organs,

cells, and biomolecules carry out the chemical and physical functions in a living system. Central to physiological functioning are biophysical and biochemical processes, homeostatic control mechanisms, and communication between cells. Physiological state is the condition of normal function of human body and other living system. These normal functions are response of some specific biochemical consequences of the living system. So how to biochemical reason is translated into physiological response that is the goal of this paper.

Course Content

Unit I: Cell **9 LECTUREHOURS**

Structure of Cell – Function of each Components of the cell – Membrane Potential – Action Potential – Generation and Conduction – Electrical Stimulation. Blood Cell – Composition – Origin of RBC – Blood Groups – Estimation of RBC, WBC and platelet.

Unit II: Cardiovascularsystem **9 LECTUREHOURS**

Cardiac Cycle – ECG – Blood Pressure – Feedback Control for Blood Pressure – Nervous control of Heart.Cardiac output – Coronary and Peripheral Circulation.

Unit III: NeuroendocrineSystem: **9 LECTUREHOURS**

Structure and function of Nervous tissue – Reflex action – Velocity of Conduction of Nerve Impulses. Electro Encephalograph – Autonomic Nervous System.

Sense organs; Optics of Eye – Retina - Photochemistry of Vision – Accommodation Neurophysiology of Vision – EOG. Physiology of Internal Ear - Mechanism of Hearing – Auditory pathway, Hearing tests. Electrical Activity of the Brain, Sleep–Wake States, & Circadian Rhythms Endocrine coordination: Mechanism of action of hormones. Different endocrine glands– Hypothalamus, pituitary, thyroid, parathyroid, pancreas and adrenals, hypo & hyper-secretions.

Unit IV: Respiratory system **9 LECTUREHOURS**

Physiological aspects of respiration. Exchange of gases – Regulation of Respiration. Disturbance of respiratory function. Pulmonary function test.

Unit V: Digestive andexcretory system **9 LECTUREHOURS**

Organization of GI system, Digestion and absorption – Movement of GI tract – Structure of Nephron, Mechanism of Urine formation – Urine Reflex – Skin and Sweat Gland – Temperature regulation.

Reference Books

6. Ganong's Review of Medical Physiology, by Kim E. Barrett and Susan M. Barman,2015.
7. Vander’s Human Physiology (2008) 11 th ed., Widmaier, E.P., Raff, H. and Strang,K.T., McGraw Hill International Publications (New York), ISBN:978-0-07-128366-3.
8. Harper’s Biochemistry (2012) 29 th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill.ISBN:978-0-07-176-576-3.

9. Textbook of Medical Physiology (2011) 10 th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN:978-1-4160-4574-8.
10. Fundamental of Anatomy and Physiology (2009), 8 th ed., Martini, F.H. and Nath,J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13:978-0321-53910-6.Chemistry of Nucleic acids,Adams.
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Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall the major systems of the human body and their functions.	**PO1, PO2, PO3, PO4, PO6, PO7,PO8**
CO2	Explain the mechanisms involved in the physiological processes of the human body.	**PO1, PO2, PO3, PO4, PO6, PO7, PO8**
CO3	Apply knowledge of human physiology to analyze and solve physiological problems.	**PO1, PO2, PO3, PO4, PO6, PO7,PO8**
CO4	Evaluate the impacts of environmental factors on human physiology.	**PO1, PO2, PO3, PO4, PO6, PO7, PO8**
CO5	Assess the ethical implications of medical advancements in human physiology	**PO1, PO2, PO3, PO4, PO6, PO7,PO8**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	3	1	3	3	3	1	1	1	1
CO2	3	3	3	3	1	3	3	3	1	1	1	1
CO3	3	3	3	3	1	3	3	3	1	1	1	1
CO4	3	3	3	3	1	3	3	3	1	1	1	1
CO5	3	3	3	3	1	3	3	3	1	1	1	1
Avg	3	3	3	3	1	3	3	3	1	1	1	1

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21520	DSE-1 Food and Dairy: Food Safety and Quality control	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	Basic Knowledge of Microbiology and Fermentation				
Co-requisites	--				

Course Objectives

1. The course will deliver basic knowledge on the principles of food fermentation and enzyme technology.
2. Specific processes related to food raw materials and food bioprocessing will bedescribed.
3. Know the basic symptoms of a Food-borne infections and intoxication caused by microorganism and how their laboratory testing procedures along with preventive measures.
4. The course will describe benefits that food biotechnology can bring during food manufacturing.

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify and explain the key principles of food safety and quality control in the food and dairy industry.

CO2. Interpret and evaluate the potential risks associated with foodborne illnesses and contamination in food and dairy products.

CO3. Apply appropriate food safety and quality control practices in the handling, processing, and storage of food and dairy products.

CO4. Analyze the effectiveness of existing food safety and quality control measures in the food and dairy industry.

CO5. Critically assess the compliance of food and dairy products with industry standards and regulatory requirements.

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Catalogue Description

Food Technology is a science branch that deals with the techniques involved in production, processing, preservation, packaging, labelling, quality management, and distribution of food products. The field also involves techniques and processes that are used to transform raw materials into food. Dairy technology study involves processing, storage, packaging, distribution and

transportation of dairy products by implying the science of bacteriology, nutrition and biochemistry.

Course Content

Food and Dairy: Food Safety and Quality control (BIT21520)

Unit I **(8 hours)**

Scope of food microbiology and biotechnology. Food as substrate for microorganisms, intrinsic and extrinsic factors affecting the growth of microbes, important microorganisms in food (molds, yeasts and bacteria) and their source (air, soil, water, plants and animals).

Unit 2 **(8 hours)**

Proximate composition of food. Sources of food contamination and spoilage. Principles of food spoilage; spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea food, poultry; spoilage of canned food; conventional and modern methods for detection of spoilage and characterization.

Unit 3 **(10 hours)**

Importance of food Preservation, Principles and methods of food preservation - Physical (temperature, irradiation, drying, canning, processing for heat treatment-D, Z and F values) Chemical (Organic acids, food additives. Class I and Class II preservatives), Biopreservation.

Food Packaging- Types of packaging materials, properties and benefits. Other methods of preservation- curing, pickling, smoking, fermentation, addition of chemical preservatives, high pressure processing, hurdle technology.

Unit 4 **(10 hours)**

Food-borne infections and intoxication: Bacterial- *Brucella, Bacillus, Clostridium, Campylobacter, Escherichia*, *Listeria*, *Vibrio*; Food intoxication- Botulism, Staphylococcal. Mycotoxins & their types – aflatoxins, ochratoxins, fuminosins, trichothecenes, zealenone, ergot alkaloids. Laboratory testing procedures. Preventive measures.

Unit 5 **(9 hours)**

SCP- Nutritional & therapeutic importance, Quorn and SCO and their Industrial production. Dairy food (cheese, srikhand). Production procedure of Kefir, Yogurt, Acidophilus milk; Probiotics, Prebiotics and Synbiotics. Nutraceuticals, functional food and their quality standards. Application of fungal pigments in food industry.

Food and sanitation: Good Hygiene Practices, Sanitation in manufacture and retail trade; food control agencies and their regulation, hazard analysis and critical control points (HACCP); GMP, quality control. Recent trends and development in food technologies in India.

Textbook:

1. Introduction to food biotechnology / Perry Johnson-Green. Latestedition.
2. James, M. J. Martin, J. Loessner, and David, A.G. (2006) Modern food microbiology (7thed.)

Reference books:

1. Bioprocess Engineering: Basic Concepts by Kargi Fikret and Schuler,2017
2. John S Norak, Gerald M Sapers, Vijaya Kumar Juneja, Daniel K Gay. (2002), .Microbial Safety of Minimally Processed Foods. 1st Edition. CRCPress.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify and explain the key principles of food safety and quality control in the food and dairy industry.	**PO1, PO2**
CO2	Interpret and evaluate the potential risks associated with foodborne illnesses and contamination in food and dairy products.	**PO1, PO2,PO3**
CO3	Apply appropriate food safety and quality control practices in the handling, processing, and storage of food and dairy products.	**PO1, PO2, PO3**
CO4	Analyze the effectiveness of existing food safety and quality control measures in the food and dairy industry.	**PO1, PO2, PO4, PO6**
CO5	Critically assess the compliance of food and dairy products with industry standards and regulatory requirements.	**PO1, PO2, PO3, PO5, PO8**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	3	3	3	0	0	0	0	0	0	0
CO4	3	3	2	3	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	3	2.6	3	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21521	DSE-1 Drug Design and Drug Development	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	Basic knowledge of Organic Chemistry and Protein Biochemistry and Engineering				
Co-requisites	--				

Course Objectives:

1. The course will explore the process of drug development, from target identification to final drugregistration.
2. It will present drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughputscreening.
3. The course will be able to teach about safety evaluation, bioavailability, clinical trials, and the essentials of patent law will also bediscussed.
4. The course will teach fundamental aspects about molecular recognition, computer aided drug design, and toxicology as applied to the development of newmedicines

Course outcome:

The students will be able

CO1: **Explain** modern techniques associated with drug design.
CO2: **Illustrate** the biological targets in the human body related to pathogenesis for novel drug discovery.
CO3: **Compare** various molecular modeling software used for designing novel drug-like molecules.
CO4: **Interpret** the role of drugs in metabolic pathways, including their adverse and therapeutic effects.
CO5: **Identify** the Structural Activity Relationship (SAR) of different classes of drugs.
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Course Description:

The subject is designed to impart knowledge about recent advances in the field of medicinal chemistry at the molecular level including different techniques for the rational drug design. At completion of this course it is expected that students will be able to apply various strategies important for designing and development of new drug like molecules. The course is also going to teach different techniques for drug discovery, their role in medicinal chemistry research, different stages involved in drug discovery with an understanding of peptidomimetics and biological targets. This subject is designed to impart the knowledge on preclinical evaluation of drugs and recent experimental techniques in the drug discovery and development. It will teach the students about developing drug safety data in Pre -clinical, Clinical phases of Drug development.

Course Content:
Drug Design and Drug Development (BIT21521)

UNITI **7 Lecture hours**

Introduction to Drugs Historical background: Sources of Drugs, Classification of drugs- important terminologies used in medicinal Chemistry. Drug Action: role of intermolecular forces
- drug targets: lipids, carbohydrates, proteins (enzymes, receptor) and nucleic acids as drug targets.

UNIT II: **8 Lecture hours**

Pharmacokinetics and pharmacodynamics: Routs of drug administration, dosage forms. Fate of drugs in the body- absorption, distribution, metabolism, and elimination of drugs (ADME). Bioavailability of drugs, drug addiction and drug toxicity.

UNITIII **8 Lecturehours**

Drugs and Their Mechanism of Action Antibacterial agents-mechanism of action-antibacterial agents that act against cell metabolism (sulfonamides), inhibit cell wall synthesis (penicillins, cephalosporins), interact with plasma membrane (valinomycin and gramicidin A), drugs impair protein synthesis (tetracyclines, chloramphenicol) and drugs act on nucleic acids (quinolones and fluoroquinolones, rifamycins). Antiviral agents-general principles-nucleic acid synthesis inhibitors (HIV, HBV), host cell penetration inhibitors, inhibitors of viral protein synthesis. Antifungal agents-azoles, allyamines and phenols. Anti-protozoal drugs (antiamoebic, Giardia, Trichomoniasis, Leishmaniasis, Anthelimintics)

UNIT IV: **7 Lecture hours**

Anticancer drugs and their mechanism of action- role of antimetabolites, antisense drugs, alkylating agents and interchelating agents in cancer chemotherapy. Cardiovascular drugs: antiarrhythemic and antihypertension drugs. Gastro intestinal drugs; Peptic ulcer, gastroesophagal reflux disorders, laxatives,antidiarrhoeal.

UNITIII **15 Lecturehours**

Drug discovery, Design and Development Identification of diseases and corresponding targets, bioassays and leads. Stereochemistry and solubility issues in drug design. Structure activity relationships (SARs): changing size and shape-introduction of new substituents. Quantitative structure activity relationships (QSARs): lipophilicity-electronic and steric effects- Hansch Analysis-Topliss decision tree. Chemical and process development of drugs. Preclinical trials: pharmacology, toxicology, metabolism and stability studies-formulation. Clinical trials: phase I-IV studies ethical issues. Patent protection and regulation.

Suggested books

1. Keith Wilson & John Walker (Ed.), Principles & Techniques of practical Biochemistry, Cambridge University,Press.
2. Burtis & Ashwood W.B. (Ed.) Tietz Textbook of Clinical Chemistry, Saunders Company.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Explain** modern techniques associated with drug design.	**PO1, PO2**
CO2	**Illustrate** the biological targets in the human body related to pathogenesis for novel drug discovery.	**PO1, PO2, PO3**
CO3	**Compare** various molecular modeling software used for designing novel drug-like molecules.	**PO1, PO2, PO3**
CO4	**Interpret** the role of drugs in metabolic pathways, including their adverse and therapeutic effects.	**PO1, PO2, PO4, PO6**
CO5	**Identify** the Structural Activity Relationship (SAR) of different classes of drugs.	**PO1, PO2, PO5, PO10**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	3	3	3	0	0	0	0	0	0	0
CO4	3	3	3	3	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	3	2.6	3	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22534	Professional Development Course-2 (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 15**	0	0	1	1
Pre-requisites/Exposure	PLUS B.SC LEVEL SCIENCE				
Co-requisites	Completion of PDC-1 course				

Catalog Description: This personal development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 1st Semester- 3rd Semester for P.G students)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1: **Create** professional resumes and cover letters tailored to specific job applications using effective resume-building techniques.
CO2: **Analyze** various interview scenarios to identify strategies for navigating different types of interview questions and formats.
CO3: **Apply** aptitude and technical skills to solve real-world problems through mock tests and assessments.
CO4: **Evaluate** personal branding and online presence to enhance professional image on platforms like LinkedIn.
CO5: **Demonstrate** effective communication skills in group discussions, presentations, and professional interactions.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	**50**	**50**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	3	2	3	0	0	0	0	0	0	0
CO4	3	3	3	3	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	3	3	2.6	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

ADAMAS UNIVERSITY
SEMESTER - III

BIT21588	Immunotechnology (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	Graduate level degree in biology or relevant area				
Co-requisites	--				

Course Objectives:

1. To provide basic understanding of our immune system and its medicalimplication.
2. To provide basic understanding of the activation, mechanism and regulation of the immune system and Host pathogeninteraction.
3. To understand how an altered signaling pathways of the immune system lead to Immune disorder.

Course Outcomes

On completion of this course, the students will be able to

CO1: Explain the basic principles of the immune system, including its components, functions, and types of immune responses.
CO2: Illustrate the principles and applications of key immunotechnology techniques, such as ELISA, immunoblotting, and flow cytometry.
CO3: Apply immunological techniques for disease diagnosis and research.
CO4: Evaluate the use of immunotherapy and vaccines in treating diseases and preventing infections.
CO5: Design immunotechnology-based strategies for disease prevention, diagnosis, and treatment.

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Catalogue Description:

Immunotechnology course will provide an advanced understanding of the principles and mechanisms of the immune system and immune responses in the context of infection, malignancy and immunological disorders. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via

exercise and discussions with thecoordinator.

Course Content: Immunotechnology (BIT21588)

Unit I **10 Lecture Hours**

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT); Mucosal Immunity; Basis of self –non-self discrimination; Kinetics of immune response.

Unit II **14 Lecture Hours**

Antigens and Immune responses generated by B and T lymphocytes

Antigens - immunogens, haptens; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.
Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling;memory cell generation; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses;

Unit III **10 Lecture Hours**

Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Immunodeficiency-Primary immunodeficiencies, Acquired or secondary immunodeficiencies.

Unit IV **10 Lecture Hours**

Vaccine technology

vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Role and properties of adjuvants, recombinant DNA and protein based vaccines

Clinical Immunology

Recognition and entry processes of different pathogens like bacteria viruses into animal and plant host cells, Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group)

UnitV **6 Lecture Hours**

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy.

Suggested Books:

1. Kuby Immunology by Judy Owen, Jenni Punt, Sharon Stranford,2013
2. Roitt's Essential Immunology (Essentials) by Ivan M. Roitt,2016
3. Medical Microbiology & Immunology by Warren Levinson,2004
4. Basic and Clinical Immunology by MarkPeakman

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Explain the basic principles of the immune system, including its components, functions, and types of immune responses.	**PO1, PO2, PO5, PO6,**
CO2	Illustrate the principles and applications of key immunotechnology techniques, such as ELISA, immunoblotting, and flow cytometry.	**PO1, PO2, PO5, PO6, PO9, PO3**
CO3	Apply immunological techniques for disease diagnosis and research.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7**
CO4	Evaluate the use of immunotherapy and vaccines in treating diseases and preventing infections.	**PO1, PO2, PO4, PO5, PO6, PO7**

CO5	Design immunotechnology-based strategies for disease prevention, diagnosis, and treatment.	**PO1, PO8, PO9, PO10, PO11, PO12**

Course Articulation Matrix

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	1	1	3	3	1	1	1	1	1	1
CO2	3	3	3	1	3	3	1	1	3	1	1	1
CO3	3	3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	1	3	3	3	3	1	1	1	1	1
CO5	3	1	1	1	1	1	1	3	3	3	3	3
Avg	3	2.6	1.8	1.8	2.6	2.6	1.8	1.4	1.8	1.4	1.4	1.4

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21522	Plant and Agricultural Biotechnology	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	B SC in Biological Science				
Co-requisites	12th level English				

Course Objectives:

1. To help the students to develop fundamental knowledge about plant tissue culture and their commercialapplications;
2. Describe the ideas about various methods of DNA transfer in plants and transgenic plantdevelopment;
3. Describe the ideas running throughout the course on the challenge of integrating various aspects of plant metabolic engineering and insights biochemical and molecularmechanisms;
4. Describe the ideas running throughout the course on modern technological tools for post-harvestmanagement;
5. At the end of the cohesive teaching, the student should obtain an integrated knowledge of all the areas of plant and agriculture biotechnology and will be able to explain their commercial implementations.

Course Outcomes

On completion of this course, the students will be able to

CO1. Recall key concepts and principles of plant tissue culture

CO2. Understand the significance of GM technology in improving crop yield and quality

CO3. Apply the principles of metabolic engineering to design strategies for enhancing plant productivity and stress tolerance.

CO4. Analyze the impact of plant biotechnology on sustainable agriculture practices and food security.

CO5. Formulate recommendations for the responsible and sustainable use of plant biotechnology in agriculture.

Catalogue Description

Plant & Agricultural Biotechnology is a challenging lecture course that covers a range of classical and modern plant biotechnological techniques. The course takes a broader approach and covers many aspects of plant biotechnology like tissue culture, transgenic plant development, plant metabolic engineering and post-harvest management. Moreover, this course elaborately highlighted the commercial application of plant and agriculture biotechnology which definitely helps the students for job searching. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching methodologies using digital platforms, such as analysis of video scenes and debates. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources,

such as, web sites, videos, DVDs, and newspapersetc.

Plant and Agricultural Biotechnology: BIT21522
Course Content: (45hours)

Unit I. Plant tissue culture (10hours)

Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

Unit II. GM Technology and Plant transformation techniques (15 hours)

Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role ofvirulencegenes; design of expressionvectors; 35Spromoter, geneticmarkers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript IIKs, pBin19, pGreen vectors, Transgene stability and gene silencing. Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato. Strategies for engineering stress tolerance. Transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labelling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds

Unit III. and Metabolic engineering of plants (10 hours)

Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway. Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenictechnology.

Unit IV. Plant Development (5hours)

Plant growth regulators, auxin, gibberlins, cytokinins, abscicic acid, and acetylene. Biological nitrogen fixation, importance and mechanism. Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorhiza, Actinorhiza Vermicomposting technology. Biopesticides. Phytoremediation.

Unit V. Post-harvest technology (5hours)

RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses

Text Books:

3. Plant Biotechnology: The Genetic Manipulation of Plants by Adrian Slater,2003
4. Biotechnology in Agriculture by Swaminathan,2009
5. Plant Tissue Culture: Propagation, Conservation and Crop Improvement

Editors: **Anis**, Mohammad, **Ahmad**, Naseem (Eds.),2011.

Reference Books

6. Plant Biotechnology by William G. Hopkins,2006
7. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recall key concepts and principles of plant tissue culture	**PO2, PO4, PO5**
CO2	Understand the significance of GM technology in improving crop yield and quality	**PO2, PO4, PO5**
CO3	Apply the principles of metabolic engineering to design strategies for enhancing plant productivity and stress tolerance.	**PO1, PO2, PO5**
CO4	Analyze the impact of plant biotechnology on sustainable agriculture practices and food security.	**PO2, PO7, PO8**
CO5	Formulate recommendations for the responsible and sustainable use of plant biotechnology in agriculture.	**PO1, PO2, PO5**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	3	2	3	3	0	0	0	0	0	0	0
CO3	3	3	3	3	3	0	0	0	0	0	0	0
CO4	3	3	3	3	3	0	0	0	0	0	0	0
CO5	3	3	3	2	3	0	0	0	0	0	0	0
Average	3	3	2.6	2.6	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21524	Animal Biotechnology (THEORY)	L	T	P	C
Version 1.0	Contact Hours – 45	3	0	0	3
Pre-requisites/Exposure	UG LEVEL BIOLOGY				
Co-requisites	--				

Course Objectives

1. To provide those students with apt introductory level knowledge to animal biotechnology.
2. It will also provide in depth knowledge of baculovirus in biocontrol and foreign gene expression.
3. Elaborating the animals asbioreactors
4. Explore the knowledge of disease diagnosis &therapy.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Identify** the basic principles and techniques of animal biotechnology

CO2. **Apply** knowledge of cell culture techniques in animal biotechnology experiments.

CO3. **Analyze** the process of transfection and its application in animal biotechnology research.

CO4. **Evaluate** the concepts and applications of stem cell and tissue engineering in the field of animal biotechnology.

CO5. Critically **assess** the role of GMOs in animal biotechnology and their impact on the environment and public health with emphasis on bioethical issues in animal biotechnology, including considerations of animal welfare, genetic manipulation, and societal implications.

Catalogue Description

The core-course of 'Animal Biotechnology' will help to understand the introductory level knowledge to animal biotechnology, baculovirus in biocontrol and its importance in foreign gene expression, animals as bioreactors. This course includes comprehensive approach through studying disease diagnosis &therapy. Furthermore, the ethical issues in animal biotechnology would also be illuminated. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as

power point presentation, audio visual virtual lab session as per requirement. The tutorials will enable the students with problem-solving ability led by the course coordinator. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

ANIMAL BIOTECHNOLOGY (BIT21524)

UNIT I. Introduction to animal biotechnology (15Hrs)

Animal cell culture and Transformation of animal cells, cloning and methods of creating transgenic animals.

UNIT II. Application of animal biotechnology and the role of baculovirus in biocontrol and foreign gene expression (15Hrs)

Improvements of animal/fish by transgenic approach with specific examples. Genetically engineered animals for pharmacological research. Embryonic stem cell culture and their applications, Embryo technology and transgenic animals; Assisted Reproductive technology, IVF. Embryonic cloning; Dolly, Polly, Molly, Megan and Morag. Biotechnology of aquaculture. Transgenic animals. –In vitro fertilization and embryo transfer. **Vectors**: Baculovirus, Adenovirus, AAV

UNIT III. Animals as bioreactors (4Hrs)

Production of IFN/TNF in milk/egg white. Cell culture based vaccines Somatic cell genetics.

Unit IV. Disease diagnosis & Therapy [9 Hrs]

Probe, PCR, LCR immunological assay. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense and RNA interference (RNAi) therapy, cell penetrating peptides, Gene therapy, Types of gene therapy, somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy, Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC. Concept of Forensic medicine, Medical transcription,Pharmacogenomics.

Stem cells and Tissue Engineering

Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronaltissues.

Unit V. **Ethical issues in animal biotechnology [2 Hrs]**

Textbook:

1. Animal Biotechnology by M.M. Ranga,2021
2. Textbook of Animal Biotechnology by Carlos Wyatt,2016

Reference books:

1. An Introduction to Genetic Engineering by Desmond S.T. Nicholl,2012
2. Genetic Engineering by WAGmob,2013
3. Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies by Richard Twine,2010.

4. Textbook of Animal Biotechnology **(**2013**)** by B. Singh **&** S.K. Gautam
5. Stem Cells: A Short Course by Rob Burgess,2015

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Identify** the basic principles and techniques of animal biotechnology	**PO1, PO2**
CO2	**Apply** knowledge of cell culture techniques in animal biotechnology experiments.	**PO1, PO2**
CO3	**Analyze** the process of transfection and its application in animal biotechnology research.	**PO1, PO2**
CO4	**Evaluate** the concepts and applications of stem cell and tissue engineering in the field of animal biotechnology.	**PO1, PO2, PO5, PO6**
CO 5	Critically **assess** the role of GMOs in animal biotechnology and their impact on the environment and public health with emphasis on bioethical issues in animal biotechnology, including considerations of animal welfare, genetic manipulation, and societal implications.	**PO1, PO2, PO3, PO5, PO8**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	3	3	3	2	2
CO2	3	3	2	3	2	3	2	2	2	2	2	2
CO3	3	3	2	3	3	3	3	3	2	2	2	3
CO4	3	2	2	3	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	3	3	3	3	3	3
Average	3	2.6	2.2	2.8	2.6	3	2.8	2.8	2.6	2.6	2.2	2.6

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21525	Process Biotechnology	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	Basic Knowledge of Genetics, RDT and Microbiology				
Co-requisites	--				

Course Objectives

1. Understand the bases for media preparation, sterilization.
2. Understand the basic structure ofBioreactors.
3. Know the basic physiology of a microorganism and how their structure dictates their function in Process Industries.
4. Outlining the relation between upstream processing and downstream processing.

Course Outcomes

On completion of this course, the students will be able to

CO1. Define key terms and concepts related to Process Biotechnology
CO2. Explain the importance of bioprocessing in producing valuable products
CO3. Design a bioprocess for the production of a specific bio-product
CO4. Determine the feasibility of scaling up a bioprocess for commercial production
CO5. Propose improvements to existing bioprocessing protocols to increase efficiency and sustainability

Catalogue Description

The focus of the course is on design of innovative microbial fermentations, for bio-products such as amino acids and monomers for bio-plastics, complemented with examples of marine and mammalian processes, for micro-algae products and bio-pharmaceuticals.

Course Content

Process Biotechnology (BIT21525)

Unit I Basic principles in Process Biotechnology [10 hrs]

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

Unit II. Bioreactors [10 hrs]

Design and Analysis of bioreactor; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional

fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design-mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit III. Downstream processing in biotechnology [5 hrs]

Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra-filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

Unit IV. Applications of enzymes and whole cell biotechnology [10 hrs]

Mechanism of enzyme function and reactions in process techniques; Enzyme bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. And their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Unit V. Fermented foods and beverages [10 hrs]

Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Waste treatments processes in Bioprocess Industry.

Textbook:

1. Bioprocess Engineering Principles by Pauline M. Doran,2012
2. Prescott &Dunn's Industrial Microbiology by G Reed,2004

Reference books:

1. Bioprocess Engineering: Basic Concepts by Kargi Fikret and Schuler,2017
2. Process Biotechnology: Theory and Practice by S. N. Mukhopadhyay,2012

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Define key terms and concepts related to Process Biotechnology	**PO1, PO2**
CO2	Explain the importance of bioprocessing in producing valuable products	**PO1, PO2,PO3**
CO3	Design a bioprocess for the production of a specific bio-product	**PO1, PO2, PO3**
CO4	Determine the feasibility of scaling up a bioprocess for commercial production	**PO1, PO2, PO4, PO6**
CO5	Propose improvements to existing bioprocessing protocols to increase efficiency and sustainability	**PO1, PO2, PO5, PO10**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	3	3	3	0	0	0	0	0	0	0
CO4	3	3	3	3	3	0	0	0	0	0	0	0
CO5	3	3	3	2	3	0	0	0	0	0	0	0
Average	3	3	2.8	2.6	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21589	Nanobiotechnology (THEORY)	L	T	P	C
Version 1.0	Contact Hours - 45	3	0	0	3
Pre-requisites/Exposure	Basic biochemistry and bio-analytical tools				
Co-requisites	Knowledge of microscopes, Fundamental of physics				

Course Objectives

1. To provide a foundational knowledge of the material science and related fields.
2. To make the students acquire an understanding the Nanoscience and its applications in biotechnology and medicinal science.
3. To help them understand in broad outline of Nanoscience and Nanotechnology.
4. To learn new techniques in devising nano-biomaterials and nanorobots.

Course Outcomes

On completion of this course,

CO1: **Understand** the fundamentals of nanomaterial science and demonstrate basic concepts in nanotechnology and nanobiotechnology.

CO2: **Illustrate** the basic techniques involved in nanomaterial fabrication.

CO3: **Describe** carbon nanotubes, quantum dots, and DNA origami, and demonstrate their applications in biosensors.

CO4: **Examine** emerging concepts under development in different laboratories.

CO5: **Develop** new ideas from existing technology with applications in diagnosis and treatment.

Course Description

This course will introduce the concept of materials, biomaterials, and nanomaterials, improve the fundamental understanding of the properties of materials at different scales, methods used in nanofabrication, and the interaction of materials with cells and the human body. The course also gives exposure to diverse applications of material science, emphasizing the precise application of nanomaterials in the pharmaceutical industry, diagnostics (biosensors), healthcare, and medicine.

Course Content: Nanobiotechnology (BIT21589)

Unit I Introduction to Materials

Surface and bulk properties of biomaterials, Types of biomaterials, Porous materials, Concept of bulk versus nanomaterials and dependence of properties on size, Cell-biomaterial interactions– In vitro assessment of compatibility of biomaterials

Unit II Introduction to nanoscience

'Top down' vs. 'Bottom up' approach of synthesis of nanomaterials with suitable examples, Classifications of nanomaterials as 1D 2D 3D nanomaterials and nanostructures

Unit II Biological nanomaterials
Nano-biomimicry, Protein and DNA- based nanostructures, S-layers as templates, carbon nanotube and its bio-applications

Unit III Nanomedicine
Pharmaceutically important nanoparticles — dendrimers, liposomes, Cellular uptake mechanisms of nanomaterials, in vitro methods to study antibacterial and anticancer properties of nanomaterials-

Unit IV Nanotoxicology and Biosafety
Classification of nanostructures based on toxicity, Route to enter into the body, Assessment of nanomaterial toxicity — cyto and hematotoxicity

Unit V Nano bio-analytics
Nanotechnology in point-of-care diagnostics, Organ-printing, Tissue engineering Nano-oncology, Nanobiosensors

Suggested Books
1. Nanobiotechnology: Concepts, Applications and Perspectives by C. M. Niemeyer, C. A. Mirkin, Wiley –VCH (2006).
2. The Handbook of Nanomedicine, by K.K. Jain. Humana press. (2008).
3. Nanotechnology: Principles and Practices by S.K. Kulkarni
4. Bionanotechnology: Lessons from Nature by D S. Goodsell, John Wiley & Sons, Inc.

Modes of Examination:

Assignment/Quiz/Project/Presentation/Written Exam Examination

Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	**Understand** the fundamentals of nanomaterial science and demonstrate basic concepts in nanotechnology and nanobiotechnology.	**PO1, PO2**
CO-2	**Illustrate** the basic techniques involved in nanomaterial fabrication.	**PO1, PO3, PO4**
CO-3	**Describe** carbon nanotubes, quantum dots, and DNA origami, and demonstrate their applications in biosensors.	**PO3, PO4, PO5**
CO-4	**Examine** emerging concepts under development in different laboratories.	**PO1, PO4, PO6**

CO-5	**Develop** new ideas from existing technology with applications in diagnosis and treatment.	**PO2, PO3, PO5, PO8**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	3	3	3	0	0	0	0	0	0	0
CO4	3	2	2	3	3	0	0	0	0	0	0	0
CO5	3	3	3	2	3	0	0	0	0	0	0	0
Average	3	2.8	2.6	2.6	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21533	DSE II: Advances in Stem Cell Research (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	1st year Master in biological science				
Co-requisites	--				

Course Objectives

1. To introduce with the latest advancements in our understanding of stem cell biology especially in human and how we can benefit from this knowledge to restore tissue homeostasis that declines upon aging which is the greatest risk factor for most human diseases. In addition, this course aims to learn lessons about rejuvenation of the immortal lineage of human germ line which is critical for propagation of species through establishment of totipotency and subsequent development to term besides trans-generational transmission of genetic and epigeneticinformation.
2. The course necessitates strong background in cellular and molecular biology which is imparted generally in the 1st year of Masters in any disciplines of biologicalsciences.
3. This knowledge is essential to inculcate interest in cutting-edge research for identifying therapeutic interventions against various degenerative diseases and to interpret the genetic and epigenetic information that is transmitted by the human germ line from one generation to the next since such information has long-term effects for generations to come which drives evolution ofspecies.

Course Outcomes

On completion of this course, the students will be able to

. **CO1**: **Outline** the fundamentals of early embryonic development, including mechanisms governing first cell fate decisions and regulatory principles of pluripotency.

CO2: **Explain** the fundamentals of human embryonic development and its relation to organogenesis and homeostasis, particularly as it deteriorates with aging.

CO3: **Interpret** the specification of the human germ line and epigenetic reprogramming through gametogenesis and fertilization, and how these processes can be simulated in the lab using synthetic gametes and embryos.

CO4: **Assess** the basis of immortality in organisms like planarians and explore how their conserved factors and pathways can be applied to ameliorate aging in humans.

CO5: **Distinguish** how the decentralization of pluripotent stem cells into multipotent or unipotent adult stem cells affects lifespan

Catalogue Description

This interdisciplinary elective course will imbibe perspective on human evolution and its consequence on extension of our health span. All the lectures will be devoted on

discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation. In addition, student will be exposed to lectures by eminent scientists from internationally renowned organizations like Stanford, Cambridge, Harvard, CNRS as well as Leibniz and Max-Planck institutes and shall also get opportunity to interact with them. The tutorials will help students to revise the basics concepts while updating themselves with the latest frontiers ofresearch.

Course Content DSE II: Advances in Stem Cell Research (BIT21533)

Unit I [12 hours]

Introduction – Definition and Criteria for Stem Cells; Pluripotent, Multipotent and Totipotent Stem cells; Primordial Germ Cells, Genomic Imprinting, Embryonic Stem Cells; Amniotic Fluid Derived Stem Cells; Cord Blood Stem Cells.

Unit II [12 hours]

Biology and Mechanisms – Molecular Basis of Pluripotency, Mechanisms of Self Renewal, Chromatin signature of pluripotent cells, Cell cycle regulators in Stem Cells; Stem Cell Niches, Change of Phenotype and Differentiation, Senescence of Dividing Somatic Cells, Aging and stem cell renewal, Quiescent StemCells.

Unit III [5 hours]

Tissue and Organ Development – Differentiation in Early Development, Potency, Commitment, Polarity and the specification of asymmetric divisions, induction, competence determination and differentiation, morphogenetic gradients, cell fate and cell lineages, Epigenetic silencing and lineage commitment; Cellular differentiation of the Nervous system, Neuronal and Glial Progenitors in Adult Brain, Epithelial Stem Cells; Adult Progenitor Cells, Mesenchymal Stem Cells,
Plasticity; De-differentiation, Cancer Stem Cells.

Unit IV [10 hours]

Stem Cell Technology – Characteristics and Characterization of Human Pluripotent Cells; Fluorescence and Magnetic bead Assisted Cell Sorting, Derivation, Characterization and Maintenance of Murine and Human Embryonic Stem Cells, Differentiation of Embryonic Stem Cells; Derivation of Induced Pluripotent Stem Cells; Derivation and Differentiation of Human Embryonic Germ Cells; (Epi)Genetic Reprogramming and re-establishment of epigenetic landscape, Fate Mapping of Stem Cells, In vitro gametogenesis (IVG), In vitro fertilization (IVF).

Unit V [6 hours]

Stem Cells and Regenerative Medicine - Neural Stem Cells in Neurodegenerative Diseases; Hematopoietic Stem Cell Transplantation and Clonal haematopoiesis; Satellite Cells; Skeletal Stem Cells; Epithelial Stem Cells and Burns; Stem Cells and

Heart Disease; Pancreatic Stem Cells and Diabetes; Intestinal Stem Cells; Liver Stem Cells and Cell Therapy for Liver Disease; Embryonic Stem Cells in Tissue Engineering, Stem Cell Banking, Ethical Concerns in Stem Cell Research, Concepts of regeneration from immortal organisms like planarians, hydra and salamander.

Reference Books

1. Essentials of Stem Cell Biology, by Robert Lanza and Anthony Atala.2013

2. Stem Cell Biology by Daniel R Marshak, Richard L. Gardner and

DavidGottlieb. 2001

3. Stem Cells: An Insider's GuideJul by Paul Knoepfler, 20134. Stem Cells: An Insider's Guide by Paul Knoepfler, 2013

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Outline** the fundamentals of early embryonic development, including mechanisms governing first cell fate decisions and regulatory principles of pluripotency.	**PO1,PO2, PO5, PO6, PO11**
CO2	**Explain** the fundamentals of human embryonic development and its relation to organogenesis and homeostasis, particularly as it deteriorates with aging.	**PO1, PO2,PO6**
CO3	**Interpret** the specification of the human germ line and epigenetic reprogramming through gametogenesis and fertilization, and how these processes can be simulated in the lab using synthetic gametes and embryos.	**PO1, PO2, PO5,PO7, PO11**
CO4	**Assess** the basis of immortality in organisms like planarians and explore how their conserved factors and pathways can be applied to ameliorate aging in humans.	**PO1, PO2, PO5**
CO5	**Distinguish** how the decentralization of pluripotent stem cells into multipotent or unipotent adult stem cells affects lifespan.	**PO1, PO2, PO6, PO7, PO8, PO12**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	2	3	3	3	0	0	0	0	0	0	0
CO4	3	3	2	3	3	0	0	0	0	0	0	0
CO5	3	3	3	2	3	0	0	0	0	0	0	0
Average	3	2.8	2.6	2.6	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21534	DSE II: Pharmaceutical Biotechnology (THEORY)	L	T	P	C
Version 1.0	**Contact Hours - 45**	3	0	0	3
Pre-requisites/Exposure	UG level knowledge of Biochemistry/Biotechnology				
Co-requisites	--				

Course Objectives

1. This course imparts a comprehension of basic skills necessary for employing biotechnology principles.
2. The knowledge gained in this course would be used to understand and evaluate the different pharmaceutical parameters of the current and future biotechnology related products on the market.
3. Novel formulation approaches for better delivery of biotechnology derived drugs, such as reverse micelles, liposomes, micro emulsions and microencapsulation will be addressed.
4. Novel biotechnology products and their use in therapeutics and diagnostics will be discussed. The advantages of these products over conventional drugs will also be discussed.
5. Special storage, handling, reconstitution and administration conditions and techniques for drug delivery systems containing bioactive macromolecules will also be discussed.

Course Outcomes

On completion of this course, the students will be able to

CO1: **Evaluate** different pharmaceutical parameters of current biotechnology products.

CO2: **Demonstrate** parameters related to the stability and formulation of biotechnology products.

CO3: **Assess** quality control procedures related to biotechnology products.

CO4: **Categorize** novel formulation methods for improved delivery of biotechnology-derived drugs.

CO5: **Design** techniques for separation and purification of cell types, measure cell turnover and growth, and conduct cytotoxicity assays.

Catalogue Description

Pharmaceutical Biotechnology is intended to provide the student with a working knowledge of the preparation, stability and formulation of different protein and peptide drugs such as antisense agents, transgenic therapeutics and gene therapy. Current FDA

approved biotechnology drugs such as human insulin, growth hormones and interferons will be discussed.

Course Content

DSE II: Pharmaceutical Biotechnology (BIT21534)

Unit I [10 hrs]

Brief introduction to Biotechnology with reference to Pharmaceutical Sciences. Enzyme Biotechnology- Methods of enzyme immobilization and applications; Biosensors- Working and applications of biosensors in Pharmaceutical Industries.

Unit II [5 hrs]

Fermentation process: Batch and continuous fermentation and fermenters, Fermentation products in Pharmaceutical industry: Antibodies, Therapeutic proteins, Vitamins, Amino acids, Monoclonal Antibodies), Principles of genetic engineering

Unit III [10 hrs]

Study of cloning vectors, restriction endonucleases and DNA ligase. Recombinant DNA technology. Application of genetic engineering in medicine. Application of r DNA technology and genetic engineering in the products: Interferon b) Vaccines-hepatitis- B c) Hormones- Insulin

UNIT IV [10 hrs]

Hypersensitivity reactions, Immune stimulation and Immune suppressions. General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity. Storage conditions and stability of official vaccines.

UNIT V [10 hrs]

Blood Products: Collection, Processing and Storage of whole human blood, dried human plasma, plasma Substituties. Regulatory aspects of biotechnology based products.

Text Books:

1. B.R. Glick and J.J. Pasternak: Molecular Biotechnology: Principles and Applications of Recombinant DNA: ASM Press WashingtonD.C.
2. RA Goldshy et. al.: KubyImmunology.
3. Stanbury F., P., Whitakar A., and Hall J., S., Principles of fermentation technology, 2nd edition, Aditya books Ltd., NewDelhi.

Reference Books:

1. J.M. Walker and E.B. Gingold: Molecular Biology and Biotechnology by Royal Society of Chemistry
2. J.W. Goding: MonoclonalAntibodies.

Modes of Evaluation: Quiz/Assignment/presentation/ extempore/ Written

Examination Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Evaluate** different pharmaceutical parameters of current biotechnology products.	**PO1, PO2, PO4, PO8, PO10**
CO2	**Demonstrate** parameters related to the stability and formulation of biotechnology products.	**PO1, PO2, PO4, PO5, PO6, PO7**
CO3	**Assess** quality control procedures related to biotechnology products.	**PO2, PO3, PO4, PO5, PO8, PO9**
CO4	**Categorize** novel formulation methods for improved delivery of biotechnology-derived drugs.	**PO1, PO4, PO5, PO6, PO9,PO10, PO11,PO12**
CO5	**Design** techniques for separation and purification of cell types, measure cell turnover and growth, and conduct cytotoxicity assays.	**PO1, PO2, PO4, PO7, PO8, PO10**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	2	3	2	3	0	0	0	0	0	0	0
CO4	3	3	3	2	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	2.8	2.6	2.4	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT21535	DSE II: Research Methodology and GLP	L	T	P	C
Version 1.0	**Contact Hours – 45**	3	0	0	3
Pre-requisites/Exposure	Basic Knowledge of Biology, application of biotechnology in industry and concept of basic and applied research.				
Co-requisites	--				

Course Objectives

1. To provide the students with understanding of research and its types along with identification of problem for conductingresearch.
2. It will also deal with the research methodology and work plan to be adopted for conducting research.
3. To study the scope of Good Laboratory Practice as an integral part of research and industrial laboratory.
4. To get introduced to various forms of quality management system (QMS) applied for biotechnological research as well as alliedindustries.

Course Outcomes

On completion of this course,

CO1: **Identify** research problems, categorize types of research, and justify the feasibility and applicability of research, inventions, or innovations.

CO2: **Select** and adopt suitable methodologies and design a research plan.

CO3: **Demonstrate** Good Laboratory Practice (GLP) in the laboratory, examine processes, identify hazards, and propose safety measures.

CO4: **Illustrate** the process of Quality Management Systems (QMS) and determine their suitability for an industry or sector.

CO5: **Recommend** actions based on the evaluation of QMS processes for improving industry or sector practices.

Catalogue Description

This course is designed to introduce the concept of research methodology to the students and provide them with understanding of research and its types along with identification of problem for conducting research. The concept of GLP will be dealt at par with international guidelines that is followed in various industries. The course will also introduce various forms of quality management system (QMS) applied for

biotechnological research as well as allied industries.

Course Content: Research Methodology and GLP (BIT21535)

Unit I [5 hrs]

Introduction to research; Definitions and characteristics of research; Types of research;Main components of any research work. Problem identification; Criteria for prioritizing problems for research. Analyzing the problem; formulating the problem statement. Literature review: Uses of literature review; Definitions and Formulation of the research objectives**.**

Unit II [10 hrs]

Research methodologies: Study population; Variables; Sampling; Sample sizedetermination; Plan for data collection; Methods of data collection; Plan for data processing andanalysis; Ethical considerations. Work Plan; Major components and outline of the different phases in a research process; Summary of the major components of a research proposal; Fieldwork; Writing a research report.

UNIT III [10 hrs]

Introduction to the WHO/TDR Handbook on GLP; Current Good Manufacturing Practices: Introduction, US Cgmp Part 210 and Part 211.EC Principles of GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force (GHTF) Guidance docs. Introduction, USFDA GLP Regulations (Subpart A to Subpart K), Controlling the GLP inspection process, Documentation, Audit, goals of Laboratory Quality Audit, Audit tools, Future of GLP regulations, relevant ISO and Quality Council of India (QCI)Standards,

UNIT IV [10 hrs]

Good Automated Laboratory Practices:Introduction to GALP, Principles of GALP, GALP Requirements, SOPs of GALP, Training Documentation,21 CFR Part 11, General check list of 21CFR Part 11, Software Evaluation checklist, relevant ISO and QCI Standards. Good Distribution Practices: Introduction to GDP, Legal GDP requirements put worldwide, Principles, Personnel, Documentation, Premises and Equipment, Deliveries to Customers, Returns, Self-Inspection, Provision of information, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), elevant CDSCO guidance and ISO standards

UNIT: V [10hrs]

Quality management systems: Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Analytical Method Validation. Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning (HVAC)]and Cleaning Validation. The International Conference on Harmonization (ICH) process, ICH guidelines to establish quality, safety and efficacy of drug substances and products, ISO 13485, Sch MIII and other relevant CDSCO regulatory guidance documents.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Identify** research problems, categorize types of research, and justify the feasibility and applicability of research, inventions, or innovations.	**PO1, PO2, PO3, PO4, PO6, PO8, PO10, PO12**
CO2	**Select** and adopt suitable methodologies and design a research plan.	**PO1, PO3,PO4, PO5, PO6,PO9**
CO3	**Demonstrate** Good Laboratory Practice (GLP) in the laboratory, examine processes, identify hazards, and propose safety measures.	**PO1, PO2, PO4, PO5 PO6, PO8, PO11**
CO4	**Illustrate** the process of Quality Management Systems (QMS) and determine their suitability for an industry or sector.	**PO4, PO5, PO6, PO8, PO9, PO10, PO11, PO12**
CO5	**Recommend** actions based on the evaluation of QMS processes for improving industry or sector practices.	**PO4, PO5, PO6, PO8, PO9, PO10, PO11, PO12**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	3	2	2	3	0	0	0	0	0	0	0
CO4	3	3	3	3	2	0	0	0	0	0	0	0
CO5	3	3	3	2	3	0	0	0	0	0	0	0
Average	3	3	2.8	2.4	2.8	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22590	Plant and Animal Biotechnology Lab	L	T	P	C
Version 1.0	Contact Hours -60	0	0	4	2
Pre-requisites/Exposure	GRADUATION LEVEL KNOWLEDGE OF PLANT BIOTECHNOLOGY				
Co-requisites	--				

Course Objectives:

1. To provide students with hands-on activities designed to encourage interest in the field of plantbiotechnology.
2. Students will need to become proficient with terms, techniques, andapplications.

Course Outcomes

On completion of this course, the students will be able to

CO1. Recall the steps involved in sterilization techniques for plant tissue culture, such as autoclaving, filtration, and chemical sterilization and contrast different types of media used in plant tissue culture, such as MS media, B5 media, and Woody Plant media, in terms of their composition and purpose.

CO2. Understand the techniques of plant tissue culture experiments and troubleshoot any issues that may arise.

CO3. Demonstrate the proper techniques for culture maintenance and cryopreservation.

CO4. Analyze and troubleshoot issues related to cell viability and growth in animal cell culture.

CO5. Assess the quality and viability of tissue cultured plants after practice hardening and maintenance procedures.

Catalogue Description

Plant Biotechnology Lab includes the application of biotechnology in plant sciences to improve the health of plants so that a good yield can be achieved. All the labs will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Animal Biotechnology Lab is the overall Learn and apply the knowledge of using different modern tools and techniques in the field of animal biotechnology. This course

covers laboratory techniques describes different modern practical methods related to animal biotechnology such as cell growth studies, cell count, protein estimation, mitotic index, karyotyping. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Plant Biotechnology

1. Media composition and Preparation of media
2. Sterilization and contamination
3. Initiation of aseptic cultures from seed, isolated embryos, and other explants
4. Callus and suspension culture
5. Study of organogenesis. Hardening and field transfer of tissue culture plants.
6. Study of somatic embryogenesis.

Animal Biotechnology

1. Development and maintenance of a cell line.
2. Karyotyping.
3. In vitro assay of drugs, predictive test for anticancer drugs.
4. Staining and screening of cells /sera for mycoplasma, viruses.
5. Cell cloning by single cell dilution method
6. LDH isozyme analysis of the given cell lines.

Suggested Books for Animal Biotechnology lab:

1.Plant cell culture – A practical approach by Dixion RA.
2.Plant tissue culture – theory and practice by Bhojwani, S.S.
3.Biotechnology: A laboratory course by Becker, J.M.
4. Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press).
5. Animal cell culture techniques, Ed. Martin clyenes (Springer).

Suggested Books for Plant Biotechnology:

2. Plant cell culture – A practical approach by Dixion RA.1995
3. Plant tissue culture by Bhojwani,S.S.2012

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO-1	Recall the steps involved in sterilization techniques for plant tissue culture, such as autoclaving, filtration, and chemical sterilization and contrast different types of media used in plant tissue culture, such as MS media, B5 media, and Woody Plant media, in terms of their composition and purpose.	**PO1,PO2, PO3, PO4, PO12**
CO -2	Understand the techniques of plant tissue culture experiments and troubleshoot any issues that may arise.	**PO1,PO2, PO3, PO4, PO6,**
CO -3	Demonstrate the proper techniques for culture maintenance and cryopreservation.	**PO1,PO2, PO3, PO4**
CO -4	Analyze and troubleshoot issues related to cell viability and growth in animal cell culture.	**PO1,PO2, PO3, PO4**
CO -5	Assess the quality and viability of tissue cultured plants after practice hardening and maintenance procedures.	**PO1,PO2, PO3, PO4, PO6**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	0	0	0	0
CO2	3	3	3	3	2	0	0	0	0	0	0	0
CO3	3	3	2	2	3	0	0	0	0	0	0	0
CO4	3	3	3	2	2	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	3	2.8	2.4	2.6	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22591	Immunotechnology Lab (PRACTICAL)	L	T	P	C
Version 1.0	**Contact Hours – 60**	**0**	**0**	**4**	**2**
Pre-requisites/Exposure	Concept of immunology at UG level				
Co-requisites	--				

Course Objectives

1. To demonstrate and interpret different antigen-antibodyinteractions.
2. To acquaint with various components of the immune system and apply this knowledge in immunodiagnostics.
3. To apply various immunological techniques for clinical and researchpurpose.
4. To quantify antigen/ antibody in differentsamples.
5. To identify and demonstrate host pathogeninteraction.

Course Outcomes

On completion of this course, the students will be able to

CO1: Demonstrate proficiency in performing fundamental immunological techniques, such as ELISA, immunoprecipitation, and immunoblotting.

CO2: Analyze and interpret data obtained from immunological experiments and assays.

CO3: Apply immunological techniques for diagnosing infectious diseases and immune disorders.

CO4: Evaluate the accuracy, sensitivity, and specificity of immunological assays used in laboratory settings.

CO5: Design and conduct experiments using immunotechnology for specific research or diagnostic purposes.

Catalogue Description

The student will be able to use the knowledge obtained to perform and analyze different types of antigen-antibody interaction. Identification of different components of the immune system is possible with the concept obtained. Students will gain the ability to apply different immunological techniques for research and clinical purposes. All the

experiments will be based on hands-on training in laboratory setup along with discussions of basic theories and advanced topics for practical implementation of knowledge. Classes will be conducted by hands-on lab training and/or audio-visual virtual lab session as per requirement. Students will perceive the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content

IMMUNOTECHNOLOGY LAB (BIT22591)

Unit I

1. To serum separation
2. To perform blood grouping
3. To perform radial immunodiffusion assay

Unit II

4. To perform immunoelectrophoresis.

Unit III

5. To quatitative precipitation assay
6. To perform quantitative immunoprecipiation assay

Unit IV

7. To perform dot-ELISA.

Unit V.

8. To perform immunoinformatics

Suggested Books:

1. Immunology Lab Manual by Wilmore Weberly, 2015
2. Immunology methods manual - The comprehensive source book by Lefkovits. , 1996
3. Manual of clinical laboratory immunology by Rose NR, 2002 4. Laboratory Immunology by Bradshaw LJ.1997

Reference books

Owen, J.A.; Punt, J.; Kuby, J.; Stranford, S.A. Kuby immunology. W.H.

Freeman: 2013. **Modes of Examination:**

Assignment/Quiz/Project/Presentation/Written Exam Examination scheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Demonstrate proficiency in performing fundamental immunological techniques, such as ELISA, immunoprecipitation, and immunoblotting.	**PO2, PO3, PO5**
CO2	Analyze and interpret data obtained from immunological experiments and assays.	**PO2, PO3, PO5**
CO3	Apply immunological techniques for diagnosing infectious diseases and immune disorders.	**PO2, PO4, PO5, PO7,PO8**
CO4	Evaluate the accuracy, sensitivity, and specificity of immunological assays used in laboratory settings.	**PO2, PO5, PO6, PO8**
CO5	Design and conduct experiments using immunotechnology for specific research or diagnostic purposes.	**PO2, PO4, PO5, PO8**

Course Articulation Matrix

CO Number	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	**1**	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO2	**1**	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO3	**1**	**3**	**1**	**3**	**3**	**1**	**3**	**3**	**1**	**1**	**1**	**1**
CO4	**1**	**3**	**1**	**1**	**3**	**3**	**1**	**3**	**1**	**1**	**1**	**1**
CO5	**1**	**3**	**1**	**3**	**3**	**1**	**1**	**3**	**1**	**1**	**1**	**1**
Avg	**1**	**3**	**1.8**	**1.8**	**3**	**1.4**	**1.4**	**2.2**	**1**	**1**	**1**	**1**

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22529	Process Biotechnology Lab	L	T	P	C
Version 1.0	**Contact Hours – 60 (2x30)**	0	0	4	2
Pre-requisites/Exposure	B SC in Biological Science				
Co-requisites	12th level English				

Course Objectives:

1. Develop basic ideas of bioprocess development and theirimplementations;
2. Students will able to discuss the basic principles operate bioreactors and interprets data with hands on training and industrialvisits;
3. Students will be able to demonstrate and design experiments for laboratory and pilot scale production of value-addedproducts;
4. Students develop their skill by hands on training in laboratory for implementing Various immobilization techniques of cells/enzymes, use of alginate for cellimmobilization;
5. At the end of the cohesive training, the student should obtain an integrated knowledge of all the areas of bioprocess engineering and will be able to perform independently different techniques associated with bioprocessdevelopment.

Course Outcomes:

On completion of this course, the students will be able to

CO1: **Demonstrate** the use of different types of bioreactors, design dedicated bioreactors for specific bioprocesses, and determine oxygen transfer rates and volumetric oxygen mass transfer coefficients (KLa) under various conditions.

CO2: **Explain** the rheology of microbial cultures and biopolymers and determine various rheological constants.

CO3: **Design** and conduct experiments for the laboratory and pilot-scale production of value-added microbial products in bioreactors.

CO4: **Demonstrate** the kinetics of enzymatic reactions by microorganisms, formulate and estimate bioenzyme production and purification, and design bioethanol production processes from microbial substrates.

CO5: **Design** and assess downstream processing of enzymes and demonstrate various immobilization techniques for cells/enzymes, including the use of alginate for cell immobilization.

Catalogue Description

Process Biotechnology practical is a skill enhancement topic which has utmost important in various applied sectors of bio-based industry as well entrepreneurship development. The course takes a broader approach and covers many spectra of bio process development in laboratory scale broadly covered by demonstration and hands on trainings as well skill development for economically viable product developments and value addition. Students are learned to operate bioreactors and fermenters as well they can be able to design experiments and be able to perform independently. We will combine traditional hands-on training with modern methodologies using digital platforms, such as analysis of video scenes and troubleshooting questionnaires. Students will be encouraged to actively take part in all group activities and to give an oral group presentation. Students will be expected to interact with media resources, such as, web sites, videos, DVDs, and newspapersetc.

Modes of Examination:
Assignment/Quiz/Project/Presentation/WrittenExam
ExaminationScheme:

Components	**Class Assessment**	**End Term**
Weightage (%)	**50**	**50**

Process Biotechnology Lab : BIT22529
Course Content: **(Each class for 2 hours = 60hours)**

Unit I **(8hours)**
Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.

Unit II **(8hours)**
Determination of mixing time and fluid flow behavior in bioreactor under variety of operating conditions.

Unit III **(4hours)**
Rheology of microbial cultures and biopolymers and determination of various rheological constants.

Unit IV **(8hours)**
Production of microbial products in bioreactors.

Unit V **(8hours)**
Studying the kinetics of enzymatic reaction by microorganisms.

Unit VI **(8hours)**
Production and purification of various enzymes from microbes.

Unit VII **(8hours)**
Comparative studies of Ethanol production using different substrates.

Unit VIII **(4hours)**
Microbial production and downstream processing of an enzyme, e.g. amylase.

Unit IX **(4hours)**

Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization

Suggested Books:

1. Laboratory Manual in Industrial Biotechnology by P. Chellapandi2007
2. Bioreactors in Biotechnology: A Practical Approach by A.H. Scragg,1991

Reference Books

1. Chellapandi P. (2007). Laboratory Manual In Industrial Biotechnology. PointerPublishers.
2. Scragg AH. (1991). Bioreactors in Biotechnology: A Practical Approach. E.Horwood

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Demonstrate** the use of different types of bioreactors, design dedicated bioreactors for specific bioprocesses, and determine oxygen transfer rates and volumetric oxygen mass transfer coefficients (KLa) under various conditions.	**PO1, PO3, PO6**
CO2	**Explain** the rheology of microbial cultures and biopolymers and determine various rheological constants.	**PO1, PO3, PO8**
CO3	**Design** and conduct experiments for the laboratory and pilot-scale production of value-added microbial products in bioreactors.	**PO2, PO7**
CO4	**Demonstrate** the kinetics of enzymatic reactions by microorganisms, formulate and estimate bioenzyme production and purification, and design bioethanol production processes from microbial substrates.	**PO1, PO3**
CO5	**Design** and assess downstream processing of enzymes and demonstrate various immobilization techniques for cells/enzymes, including the use of alginate for cell immobilization.	**PO1, PO2, PO5, PO6**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	0	0	0	0	0	0	0
CO2	3	3	2	3	3	0	0	0	0	0	0	0
CO3	3	3	3	2	2	0	0	0	0	0	0	0
CO4	3	3	3	2	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	3	2.6	2.6	2.6	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT24530	Industry Internship	L	T	P	C
Version 1.0	-	0	0	0	2
Pre-requisites/Exposure	Graduate level degree in biology or relevant area				
Co-requisites	--				

Course Objectives:

1. Students will have the opportunity to put content from the classroom into practice consistent with the standards of theindustry.
2. The primary goal of this course is to acquaint students with business or agency culture and to help them identify roles in that culture where scientific expertise in biotechnology is relevant.
3. Students will understand professional, ethical and social responsibilities and develop a respect for diversity and a knowledge of contemporary professional, societaland global issues of the need and an ability to engage in lifelonglearning,

Course Outcomes

On completion of this course, the students will be able to

CO1: **Illustrate** the operations of a biotechnology industry or research lab and the use of high-end instruments/software.

CO2: **Demonstrate** professional behavior, including conscientious performance and a collaborative work ethic.

CO3: **Apply** biotechnology knowledge and skills in industrial or research labs, appreciating ethical business principles and practices.

CO4: **Evaluate** technical information through written reports and oral presentations, focusing on observation, analysis, and results.

CO5: **Develop** knowledge of contemporary professional, societal, and global issues, and engage in lifelong learning.

Catalogue Description:

Students participate in research or applied biology outside this university. Students must contact and obtain approval of a supervising instructor at the off-campus location and the department internship coordinator in the term prior to registration. Students have the opportunity to put content from the classroom into practice consistent with

the standards of the industry. Industry internships are a powerful way for students to experience biotechnology first-hand and set them up for future employment. Industrial internship of approximately two months duration is required, and typically in the second year of Master's degreecourse.

Course Content:

Industry Internship (BIT24530)

Student Notebook and Portfolio: A bound, paged notebook should serve as a reservoir of observations, results or conclusions about daily activities during the internship. Each date should be entered with a title of the activity in a form that can be listed in the table of contents, with appropriate page numbers. A brief concluding statement which suggests awareness of the purpose and important events or results acquired during the day should appear following any other observations or entries followed by the intern's signature. In addition, any interim projects or progress reports should be assembled or otherwise documented into a portfolio of products or findings arising from theinternship.

Written Presentation: At the conclusion of the assignment student will be required to submit a formal written progress report a summary of the important findings; and a statement regarding the impact of these findings on future operations or directions relative to the problem under investigation.

Oral Presentation: Each student is required to make a formal oral presentation on the experience. The presentations will summarize the findings and the overall experience, especially reflecting on the experience relative to the course goal and learning objectives.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Report submission**	**Presentation**
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**

CO1	**Illustrate** the operations of a biotechnology industry or the operations of a lab, use ofhigh-end research lab and the use of high-end instruments/software.	**PO1, PO2, PO4, PO5**
CO2	**Explain** the rheology of microbial cultures and biopolymers and determine various rheological constants.	**PO1, PO2, PO4, PO7, PO8, PO9**
CO3	**Design** and conduct experiments for the laboratory and pilot-scale production of value-added microbial products in bioreactors.	**PO1, PO2, PO3, PO4, PO7, PO8, PO11**
CO4	**Demonstrate** the kinetics of enzymatic reactions by microorganisms, formulate and estimate bioenzyme production and purification, and design bioethanol production processes from microbial substrates.	**PO1, PO2,PO3, PO4, PO5, PO6**
CO5	**Design** and assess downstream processing of enzymes and demonstrate various immobilization techniques for cells/enzymes, including the use of alginate for cell immobilization.	**PO1, PO2, PO4, PO7, PO8, PO10, PO11, PO12**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	0	0	0	0	0	0	0
CO2	3	3	2	3	3	0	0	0	0	0	0	0
CO3	3	3	3	2	3	0	0	0	0	0	0	0
CO4	3	3	3	3	3	0	0	0	0	0	0	0
CO5	3	2	2	3	3	0	0	0	0	0	0	0
Average	3	2.8	2.6	2.6	2.6	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT22535	Professional Development Course-3 (Practical)	L	T	P	C
Version 1.0	**Contact Hours - 15**	0	0	1	1
Pre-requisites/Exposure	PLUS B.SC LEVEL SCIENCE				
Co-requisites	Completion of PDC-2 course				

Catalog Description: This personal development course aims to help you discover and achieve your goals by focusing on organization and action. You'll learn techniques to enhance goal-setting, communication, self-motivation, and a positive attitude, empowering you to maximize your performance both academically and professionally.

Course Syllabus:

The syllabus for Professional Development Course-I for senior students (preferably 1st Semester- 3rd Semester for P.G students)

1. Introduction to Pre-Placement Training.
2. Resume Building & Cover Letter Writing.
3. Interview Skills.
4. Aptitude and Technical Skills.
5. Group Discussion and Communication Skills.
6. Personal Branding and Online Presence.
7. Professional Skills.
8. Industry Insights and Company Presentations.
9. Career Guidance for competitive entrance exams and Job Search Strategies
10. Mock Tests and Assessments.

Course learning outcomes:

CO1: **Create** professional resumes and cover letters tailored to specific job applications, demonstrating effective resume-building techniques.

CO2: **Analyze** various interview scenarios to identify key strategies for navigating different types of interview questions and formats.

CO3: **Apply** aptitude and technical skills to solve real-world problems through mock tests and assessments.

CO4: **Evaluate** personal branding and online presence, making necessary adjustments to enhance professional image on platforms like LinkedIn.

CO5: **Demonstrate** effective communication skills in group discussions, presentations, and professional interactions.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	CA	End Term
Weightage (%)	50	50

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	0	0	0	0	0	0	0
CO2	3	2	2	3	3	0	0	0	0	0	0	0
CO3	3	3	2	2	3	0	0	0	0	0	0	0
CO4	3	3	3	2	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	2.8	2.4	2.4	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

ADAMAS UNIVERSITY
SEMESTER - IV

BIT25540	Comprehensive Viva	L	T	P	C
Version 1.0		0	0	0	2
Pre-requisites/Exposure	Knowledge about the biotechnology at M.Sc level				
Co-requisites	-				

Course Objectives

1. Defining and outlining a research area with a clearquestion
2. Identifying the leadingissues
3. Sourcing the relevantinformation
4. Evaluating the evidence on all sides of adebate
5. Coming to a well-argued conclusion

Course Outcomes

On completion of this course, the students will be able to

CO1: **Demonstrate** knowledge during interviews for biotechnology-related jobs.

CO2: **Appraise** knowledge during interviews for biotechnology research positions.

CO3: **Develop** the skill to conclude scientific facts.

CO4: **Discuss** biological data.

CO5: **Build** a professional identity as a skilled biotechnologist in society.

Catalogue Description

The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Biotechnology acquired over 2 years of study in the postgraduate program

Course Content

Reading of Biotechnology Text books, very recent research papers from high impact journals containing biology research work and also performance of laboratory based research orientedexperiments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	**Viva**
Weightage (%)	**100**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Demonstrate** knowledge during interviews for biotechnology-related jobs.	**PO1, PO2, PO5, PO6,PO8**
CO2	**Appraise** knowledge during interviews for biotechnology research positions.	**PO1, PO4, PO5,PO6, PO7,PO10**
CO3	**Develop** the skill to conclude scientific facts.	**PO1, PO2, PO3,PO6, PO7,PO10**
CO4	**Discuss** biological data.	**PO1, PO2, PO4, PO5, PO8, PO10**
CO5	**Build** a professional identity as a skilled biotechnologist in society.	**PO1, PO2, PO3, PO4, PO5, PO6,PO7, PO8, PO9, PO10,PO11, PO12**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	0	0	0	0	0	0	0
CO2	3	3	2	3	3	0	0	0	0	0	0	0
CO3	3	3	2	2	3	0	0	0	0	0	0	0
CO4	3	2	3	3	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	2.6	2.4	2.8	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

BIT25541	Project work and Viva	L	T	P	C
Version 1.0		0	0	30	15
Pre-requisites/Exposure	Knowledge about biotechnology and allied fields				
Co-requisites	-				

Course Objectives

1. Defining and outlining a research area with a clearquestion
2. Identifying the leadingissues
3. Sourcing the relevantinformation
4. Assessing its reliability andlegitimacy
5. Evaluating the evidence on all sides of adebate
6. Coming to a well-arguedconclusion

Course Outcomes

On completion of this course, the students will be able to

CO1: **Design** and perform a new type of experiment.
CO2: **Summarize** observations from experiments.
CO3: **Develop** skills to create data tables.
CO4: **Conclude** from the data.
CO5: **Infer** whether the data is novel or as expected.

Catalogue Description

Dissertation allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university, with the assessment used to help determine their final grade. Although there is usually some guidance from your tutors, the dissertation project is largely independent.

Course Content

1. Reading of very recent research papers from high impact journals containing biochemical/allied-field research work and also performance of laboratory based research oriented experiments.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Thesis	Presentation
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	**Design** and perform a new type of experiment.	**PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO9, PO11**
CO2	**Summarize** observations from experiments.	**PO1, PO2, PO5, PO6, PO7, PO8, PO10, PO11**
CO3	**Develop** skills to create data tables.	**PO1, PO2, PO5, PO3, PO4, PO8, PO10**
CO4	**Conclude** from the data.	**PO4, PO6, PO8, PO10, PO11**
CO5	**Infer** whether the data is novel or as expected.	**PO1, PO2, PO4, PO6, PO8, PO9, PO10, PO11, PO12**

Course Articulation Matrix

CO Number	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	0	0	0	0	0	0	0
CO2	3	3	3	3	3	0	0	0	0	0	0	0
CO3	3	2	2	3	3	0	0	0	0	0	0	0
CO4	3	3	2	2	3	0	0	0	0	0	0	0
CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average	3	2.6	2.6	2.8	3	0	0	0	0	0	0	0

CO and PO in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium) and 3 being substantial (high).

ADAMAS UNIVERSITY
SCHOOL OF LIFE SCIENCE &
BIOTECHNOLOGY DEPARTMENT OF
BIOTECHNOLOGY

CO – PO MAPPING

Name of the Programme: M.Sc. in Biotechnology
Specialization: NA

Course Title and Course Code	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Biomolecules and Biomolecular Interactions (BIT21580)	CO1	3	3	3	2	3	2	1	-	-	-	-	-
	CO2	3	3	2	3	3	3	2	-	-	-	-	-
	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	2	3	3	-	-	-	-	-
	CO5	3	3	3	3	2	3	3	-	-	-	-	-
Biophysical Chemistry & Bioanalytical Techniques (BIT21502)	CO1	3	3	3	2	3	2	1	-	-	-	-	-
	CO2	3	3	2	3	3	3	2	-	-	-	-	-
	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	3	3	3	-	-	-	-	-
	CO5	3	3	3	3	2	3	3	-	-	-	-	-
Applied Microbiology (BIT21590)	CO1	3	3	3	2	3	2	2	-	-	-	-	-
	CO2	3	3	3	3	3	3	2	-	-	-	-	-
	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	3	3	3	-	-	-	-	-
	CO5	3	3	3	3	3	3	3	-	-	-	-	-
Molecular Genetics (BIT21504)	CO1	3	3	2	2	2	2	2	-	-	-	-	-
	CO2	3	3	3	3	3	3	3	-	-	-	-	-
	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	3	3	3	-	-	-	-	-
	CO5	3	3	3	3	3	3	3	-	-	-	-	-
Ecology and Evolution (BIT21581)	CO1	3	3	1	1	1	1	1	1	1	3	1	1
	CO2	3	3	1	1	1	1	1	1	1	3	1	1

	CO3	3	3	1	1	3	3	3	1	1	1	1	1
	CO4	3	3	1	1	1	1	1	3	3	1	3	3
	CO5	3	3	3	1	1	3	3	3	1	1	1	1
Bio-Ethics and Intellectual Property Rights (BIT21536)	CO1	3	3	3	3	2	3	3	3	3	3	3	2
	CO2	3	3	3	3	2	3	2	2	2	2	3	2
	CO3	3	3	2	3	3	3	3	3	2	2	3	3
	CO4	3	2	2	3	3	3	3	3	3	3	3	3
	CO5	3	2	2	2	3	3	3	3	3	3	3	3
Biophysical Chemistry and Bioanalytical Techniques Lab (BIT22582)	CO1	3	3	2	2	3	2	1	-	-	-	-	-
	CO2	3	3	3	3	3	3	2	-	-	-	-	-
	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	3	3	3	-	-	-	-	-
	CO5	3	3	3	3	3	3	3	-	-	-	-	-
Applied Microbiology and Molecular Genetics Lab (BIT22531)	CO1	3	3	2	2	3	2	2	-	-	-	-	-
	CO2	3	3	3	3	3	3	2	-	-	-	-	-
	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	3	3	3	-	-	-	-	-
	CO5	3	3	3	3	3	3	3	-	-	-	-	-
Professional Development Course-1 (BIT22533)	CO1	3	3	2	3	2	2	1	3	-	-	-	3
	CO2	3	3	3	3	3	3	2	3	-	-	-	3
	CO3	3	3	3	3	3	3	3	3	-	-	-	3
	CO4	3	3	3	3	3	3	3	3	-	-	-	3
	CO5	3	3	3	3	3	3	3	3	-	-	-	3
Molecular Biology (BIT21509)	CO1	3	3	2	3	3	2	2	-	-	-	-	3
	CO2	3	3	3	3	3	3	2	-	-	-	-	3
	CO3	3	3	3	3	3	3	3	-	-	-	-	3
	CO4	3	3	3	3	3	3	3	-	-	-	-	3
	CO5	3	3	3	3	3	3	3	-	-	-	-	3
Advanced Recombinant DNA Technology (BIT21510)	CO1	3	3	2	3	3	2	2	-	-	-	-	3
	CO2	3	3	3	3	3	3	2	-	-	-	-	3
	CO3	3	3	3	3	3	3	3	-	-	-	-	3
	CO4	3	3	3	3	3	3	3	-	-	-	-	3
	CO5	3	3	3	3	3	3	3	-	-	-	-	3
	CO1	3	3	3	3	3	3	3	-	-	-	-	-
	CO2	3	3	2	3	3	3	3	-	-	-	-	-

Applied Genomics and Proteomics (BIT21591)	CO3	3	3	3	3	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	3	3	3	-	-	-	-	-
	CO5	3	3	3	3	2	3	3	-	-	-	-	-
Bioinformatics and Biostatistics (BIT21585)	CO1	3	3	2	3	3	2	2	-	-	-	-	3
	CO2	3	3	3	3	3	3	2	-	-	-	-	3
	CO3	3	3	3	3	3	3	3	-	-	-	-	3
	CO4	3	3	3	3	3	3	3	-	-	-	-	3
	CO5	3	3	3	3	3	3	3	-	-	-	-	3
Molecular Biology and Recombinant DNA Technology Lab (BIT22586)	CO1	3	3	2	3	3	2	2	0	0	0	0	3
	CO2	3	3	3	3	3	3	2	0	0	0	0	3
	CO3	3	3	3	3	3	3	3	0	0	0	0	3
	CO4	3	3	3	3	3	3	3	0	0	0	0	3
	CO5	3	3	3	3	3	3	3	0	0	0	0	3
Applied Genomics and Proteomics Lab (BIT22532)	CO1	3	3	3	3	3	3	1	-	-	-	-	-
	CO2	3	2	3	3	3	3	2	-	-	-	-	-
	CO3	3	3	3	2	3	3	3	-	-	-	-	-
	CO4	3	3	3	3	2	3	3	-	-	-	-	-
	CO5	3	3	3	3	3	3	2	-	-	-	-	-
Bioinformatics Lab (BIT22516)	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	3	2	2	3	0	0	0	0	0	0	0
	CO3	2	3	3	2	3	0	0	0	0	0	0	0
	CO4	3	3	2	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
DSE-I CANCER BIOLOGY (BIT21517)	CO1	3	3	2	3	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	3	2	3	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
DSE-I Human Physiology (BIT21518)	CO1	3	3	3	3	1	3	3	3	1	1	1	1
	CO2	3	3	3	3	1	3	3	3	1	1	1	1
	CO3	3	3	3	3	1	3	3	3	1	1	1	1
	CO4	3	3	3	3	1	3	3	3	1	1	1	1
	CO5	3	3	3	3	1	3	3	3	1	1	1	1
	CO1	3	3	2	3	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0

Food and Dairy: Food Safety and Quality control (BIT21520)	CO3	3	3	3	3	3	0	0	0	0	0	0	0
	CO4	3	3	2	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Drug Design and Drug Development (BIT21521)	CO1	3	3	2	3	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	3	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Professional Development Course-2 (BIT22534)	CO1	3	3	3	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	2	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Immunotechnology (BIT21588)	CO1	3	3	1	1	3	3	1	1	1	1	1	1
	CO2	3	3	3	1	3	3	1	1	3	1	1	1
	CO3	3	3	3	3	3	3	3	1	1	1	1	1
	CO4	3	3	1	3	3	3	3	1	1	1	1	1
	CO5	3	1	1	1	1	1	1	3	3	3	3	3
Plant and Agricultural Biotechnology: BIT21522	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	3	2	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	3	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	2	3	0	0	0	0	0	0	0
ANIMAL BIOTECHNOLOGY (BIT21524)	CO1	3	3	3	3	2	3	3	3	3	3	2	2
	CO2	3	3	2	3	2	3	2	2	2	2	2	2
	CO3	3	3	2	3	3	3	3	3	2	2	2	3
	CO4	3	2	2	3	3	3	3	3	3	3	2	3
	CO5	3	2	2	2	3	3	3	3	3	3	3	3
Process Biotechnology (BIT21525)	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	3	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	2	3	0	0	0	0	0	0	0
Nanobiotechnology (BIT21589)	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	3	3	0	0	0	0	0	0	0
	CO4	3	2	2	3	3	0	0	0	0	0	0	0

	CO5	3	3	3	2	3	0	0	0	0	0	0	0
DSE II: Advances in Stem Cell Research (BIT21533)	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	2	3	3	3	0	0	0	0	0	0	0
	CO4	3	3	2	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	2	3	0	0	0	0	0	0	0
DSE II: Pharmaceutical Biotechnology (BIT21534)	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	2	3	2	3	0	0	0	0	0	0	0
	CO4	3	3	3	2	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Research Methodology and GLP (BIT21535)	CO1	3	3	3	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	3	2	2	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	2	0	0	0	0	0	0	0
	CO5	3	3	3	2	3	0	0	0	0	0	0	0
Plant and Animal Biotechnology Lab (BIT22590)	CO1	3	3	3	2	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	2	0	0	0	0	0	0	0
	CO3	3	3	2	2	3	0	0	0	0	0	0	0
	CO4	3	3	3	2	2	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
IMMUNOTECHNOLOGY LAB (BIT22591)	CO1	1	3	3	1	3	1	1	1	1	1	1	1
	CO2	1	3	3	1	3	1	1	1	1	1	1	1
	CO3	1	3	1	3	3	1	3	3	1	1	1	1
	CO4	1	3	1	1	3	3	1	3	1	1	1	1
	CO5	1	3	1	3	3	1	1	3	1	1	1	1
Process Biotechnology Lab (BIT22529)	CO1	3	3	2	3	3	0	0	0	0	0	0	0
	CO2	3	3	2	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	2	2	0	0	0	0	0	0	0
	CO4	3	3	3	2	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Industry Internship (BIT24530)	CO1	3	3	3	2	2	0	0	0	0	0	0	0
	CO2	3	3	2	3	3	0	0	0	0	0	0	0
	CO3	3	3	3	2	3	0	0	0	0	0	0	0
	CO4	3	3	3	3	3	0	0	0	0	0	0	0
	CO5	3	2	2	3	3	0	0	0	0	0	0	0

Professional Development Course-3 (BIT22535)	CO1	3	3	2	2	3	0	0	0	0	0	0	0
	CO2	3	2	2	3	3	0	0	0	0	0	0	0
	CO3	3	3	2	2	3	0	0	0	0	0	0	0
	CO4	3	3	3	2	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Comprehensive Viva (BIT25540)	CO1	3	2	2	3	3	0	0	0	0	0	0	0
	CO2	3	3	2	3	3	0	0	0	0	0	0	0
	CO3	3	3	2	2	3	0	0	0	0	0	0	0
	CO4	3	2	3	3	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Project work and Viva (BIT25541)	CO1	3	2	3	3	3	0	0	0	0	0	0	0
	CO2	3	3	3	3	3	0	0	0	0	0	0	0
	CO3	3	2	2	3	3	0	0	0	0	0	0	0
	CO4	3	3	2	2	3	0	0	0	0	0	0	0
	CO5	3	3	3	3	3	0	0	0	0	0	0	0
Average of CO-PO Mapping		**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**2**

***List all the courses CO-PO Mapping in this Table and find theaverage.**
***While averaging consider only the CO which represents particularPO**

Note: All the POs and PSOs should be mapped at least one or two COs. None will be left unmapped.