যাদবপুর বিশ্ববিদ্যালয়
JADAVPUR UNIVERSITY

DEPARTMENT OF LIFE SCIENCE AND BIOTECHNOLOGY

New Syllabus for the Revised Two Year (Four Semester) Course in M. Sc. in Biotechnology

Offered by
DEPARTMENT OF LIFE SCIENCE AND BIOTECHNOLOGY
FACULTY OF SCIENCE
JADAVPUR UNIVERSITY

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JADAVPUR UNIVERSITY

DEPARTMENT OF LIFE SCIENCE AND BIOTECHNOLOGY

1. Name of the department/School	:	**LIFE SCIENCE AND BIOTECHNOLOGY**
2. Name of the course offered [certificate, diploma, degree (UG / PG / M.Phil. / Ph.D.), Extra-departmental, training, vocational, etc.]	:	➢ M.Sc. in Biotechnology ➢ Ph.D. in Science
3. Eligibility criteria, course-wise	:	B.Sc. in any branch of Science with 50% Marks in Mathematics at 10+2 levels (H.S., ISC, etc)
4. Dissemination, course-wise (full-time day; part-time, Evening, 2-3 days per week; Distance mode, etc.)		Full Time Day course for M. Sc. in Biotechnology
5. Duration, course-wise :		2 years for M. Sc. in Biotechnology
6. Curriculum/Syllabus, course-wise :		Enclosed herewith

Preamble: Biotechnology Education at Jadavpur University

Biotechnology programme in Jadavpur University stared with a master's course M. Tech. (Biotechnology) in the year 1985, the initial objective was to induct engineering graduates into this emerging technology and train them to support the growing biotechnology industry of the country.

Later postgraduates in different science streams were also admitted. The overall experience in fulfilling the above objectives had been satisfactory. At a later stage, however, most of the students coming from the engineering streams were Pharmacy graduates (B. Pharm.), few students used to come from chemical engineering or food Technology. Among the science students the response was more encouraging.

After that, a two year M. Sc. in Biotechnology program was introduced, in which the students form all disciplines of Science, eg. Physics, Chemistry, Mathematics, Zoology, Botany, Physiology, Microbiology and Biochemistry honours graduate were inducted. Most of the graduated students opted for further research to earn their Ph. D. degree from JU as well as other reputed Universities in India and abroad. A small number of students joined various private biotechnology, pharma and other industries. Yet another smaller fraction went for several government sector.

Evolving nature of Biotechnology Education in Jadavpur University

The current M.Sc. (Biotechnology) curriculum was adopted and modernized in year 2005. In doing so an appropriate blend between science and technology was effected and newer areas such as biostatistics, genomics, proteomics, bio-informatics, bio-economics, intellectual property rights, emerging areas of genomic and transcriptomic technologies used in microbial, plant, animal biotechnology etc were incorporated into the syllabus.

In this revised M. Sc. (Biotechnology) curriculum, the major change that was emphasized is the introduction of the semester module. In addition, many less important topics in various courses were reduced and newer and modern topics, which are more relevant to the current needs of the subject, were introduced. Moreover, in the fourth semester, two new course module were introduced that does not follow the traditional classroom based-teaching learning module. Rather they involve critical skills involving analyses, thinking, presentation and dissemination of knowledge. This new revised syllabus is very time-appropriate, that would train the students to build suitable skills and help them to get appropriate career-option/employment down the line.

Current Needs and prospects

- Catering a quality education to students coming from different backgrounds requires optimization and maintenance of correct subjects/topics in proper blend and providing the advance quality education is a quite challenging.

- With biotechnology (or biological technology) becoming increasingly knowledge (science) Based, the basic sciences such as structural biology, molecular biology, cell biology as well as genomics and proteomics need to be more elaborate than present syllabus can accommodate.

- The current syllabus runs on annual examination based examination system and currently, it is mandatory to transform the course into semester system to be consistent with the UGC requirement and also to be at per with the other M. Sc. courses under faculties if Science at Jadavpur University

- Jadavpur University attracts the best of the students from all over the state from different disciplines.

- The current M. Sc. (Biotechnology) programme needs a through recasting in order to be at par with other M. Sc. (Biotechnology) courses offered at other institution/universities. This is essential for catering the information of the most recently developed cutting-edge technologies to improve the quality of the passed-out students to ensure (i) entry into the appropriate research area and (ii) employment.

With the above mentioned needs and prospects in consideration we are in the process of starting the newly developed syllabus in M. Sc. (Biotechnology) from the next academic session (2019-20).

Vision of the Department:

To thrive as a vibrant, diverse and socially responsible community promoting high quality teaching and research in modern Biotechnology.

Mission of the Department:

The mission of the Department of Life Science and Biotechnology is

- To cater a quality education to heterogeneous group of students coming from different backgrounds by maintaining a proper blend of diverse subjects.
- To instruct a high quality global learning in the multidisciplinary aspects of Biotechnology with a thrust on Basic Life Sciences, Chemistry, Physics, and Mathematics.
- To create leaders who are capable of pursuing high-quality research of international standard at various leading research institutes of national reputes.
- To prepare employable industry-ready individuals capable of continuous life-long learning, team work with ethical professionalism.

Program Educational Objectives (PEOs)

PEO 1: Learn, understand and apply the fundamental and advanced concepts of Biotechnology, computational techniques, instrumentation and all related aspects for pursuing higher studies/ research and successful careers in industry.

PEO 2. Utilize the foundational knowledge and methodological expertise to pursue higher education and research in reputed institutes at national and international level.

PEO 3. Apply the acquired theoretical knowledge and practical skills in the development of various products, processes, techniques and resources to meet the societal demands.

PEO 4. Equip the student-awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

Mission-PEO Matrix

	M1	M2	M3	M4
PEO1	3	3	2	3
PEO2	3	2	3	2
PEO3	3	3	2	3
PEO4	1	1	2	3

Correlation levels- 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Program Outcomes (POs)

Program Outcomes	Description
PO-1	**Implementation of Scientific Knowledge:** Apply the knowledge of mathematics and natural sciences to the solution of scientific problems.
PO-2	**Critical Thinking and Problem Analysis:** Inculcate critical thinking to identify the problems and formulate various methodologies for obtaining their solutions.
PO-3	**Design/Development of Solutions**: Design a system and prepare formal methodical plans, leading to solutions.
PO-4	**Conduct innovative research**: Formulate the structure and components of a research problem and investigate it with an aim for solution.
PO-5	**Usage of Modern Methods and Tools for Professional Skill Development**: Develop/ select and apply appropriate methods/tools for solving problems in research and applied fields.
PO-6	**The Science and Society:** Apply scientific knowledge to assess and address critical societal issues.
PO-7	**Environment and Sustainability:** Appreciate social and environmental issues and provide scientific know-hows for the use of renewable resources.
PO-8	**Ethics**: Understand academic and professional ethics, legal, societal and security issues, and shoulder responsibilities.
PO-9	**Individual and teamwork**: Build capacity to work independently and also as a team member for collaborative work.
PO-10	**Communication**: Develop skills to communicate effectively with seniors, colleagues, other team members and society at large.
PO-11	**Project Management and Finance:** Understand the management principles and appreciate financial implications/issues pertaining to any scientific project.
PO-12	**Life-long learning**: Identify contemporary issues in the context of changing academic, technological and socio-political scenarios and engage in lifelong learning.

PROGRAMME SPECIFIC OUTCOMES

PSO 1	Acquire knowledge on the fundamentals of biotechnology for sound and solid base enabling them to understand the emerging and advanced technological concepts in life sciences.
PSO 2	Acquire knowledge in domain of biotechnology enabling their applications in industry and research.
PSO 3	Empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology
PSO 4	Recognize the importance of Bioethics, IPR, entrepreneurship, Communication and management skills so as to prepare next generation of researchers.

Department of Life Science and Biotechnology
Jadavpur University

Syllabus of Two Year (Four Semester) course in M. Sc. (Biotechnology)

Semester I

Minimum Semester Credit Required: 28
Cumulative Semester Credit Required: 28
Theoretical = 200, Practical = 100

Subject	Course No	Subject Name	Lecture/Contact Hr./Week	Credit	Total Marks
Theory	SC/BT/PG/131T	Cell Biology	3	3	50
Theory	SC/BT/PG/132T	Biochemistry	3	3	50
Theory	SC/BT/PG/133T	Fundamentals of Molecular Biology and Microbial Genetics	3	3	50
Theory	SC/BT/PG/134T	Biomathematics, Biostatistics and Computer	3	3	50
Lab Course	SC/BT/PG/185L	Microbiology and Biochemistry Laboratory*	20	8	50
Lab Course	SC/BT/PG/186L	Biophysics and Cell Biology Laboratory*	20	8	50
		TOTAL		28	300

*Out of 50 in Practical

Internal Assessment = 30
Viva = 15
Lab note book = 5

Semester II

Minimum Semester Credit Required: 18
Cumulative Semester Credit Required: 46
Theoretical = 300

Subject Type	Course No	Subject Name	Lecture/Contact Hr./Week	Credit	Total Marks
Theory	SC/BT/PG/231T	Advanced Molecular Biology and Genetics	3	3	50
Theory	SC/BT/PG/232T	Metabolism and Bioenergetics	3	3	50
Theory	SC/BT/PG/233T	Immunology	3	3	50
Theory	SC/BT/PG/234T	Microbiology	3	3	50
Theory	SC/BT/PG/235T	Bioinformatics	3	3	50
Theory	SC/BT/PG/236T	Bio-analytical Techniques	3	3	50
		TOTAL		18	300

Semester III

Minimum Semester Credit Required: 28
Cumulative Semester Credit Required: 74
Theoretical = 200, Practical = 100

Subject Type	Course No	Subject Name	Lecture/Contact Hr./Week	Credit	Total Marks
Theory	SC/BT/PG/331T	Recombinant DNA Technology	3	3	50
Theory	SC/BT/PG/332T	Genomics and Proteomics	3	3	50
Theory	SC/BT/PG/GE/363T	Animal and Developmental Biotechnology **	6	6	100
Theory	SC/BT/PG/GE/364T	Plant and Microbial Biotechnology**	6	6	100
Lab Course	SC/BT/PG/385L	Immunology Laboratory	20	8	50
Lab Course	SC/BT/PG/386L	Molecular Biology and Recombinant Technology Laboratory	20	8	50
		TOTAL		28	300

****Elective, CBCS Course and each of them will carry 6 Credit Points**

Semester IV

Minimum Semester Credit Required: 32
Cumulative Semester Credit Required: 106
Theoretical = 100, Project Based = 100, Grand Viva = 100

Subject Type	Course No	Subject Name	Lecture/Contact Hr./Week	Credit	Total Marks
Theory	SC/BT/PG/481T	Selected Topics in Biotechnology*	3	8	50
Skill Enhancement Course	SC/BT/PG/482SEC	Critical Analysis Research methodology and Scientific Communication Skill¥	3	8	50
Skill Enhancement Course	SC/BT/PG/483SEC	Students Project Work and Dissertation	3	8	100
Skill Enhancement Course	SC/BT/PG/484SEC	Grand Viva	3	8	100
		TOTAL		32	300

*Out of 50 in Practical

Internal Assessment = 30
Viva = 15
Lab note book = 5

Detailed Contents of the Syllabus

Semester I

SC/BT/PG/131T: Cell biology

Course code and Name:	**SC/BT/PG/131T, Cell Biology**	**L T P C** **3 0 0 3**
Course Prerequisites	**Basic knowledge in Biology**	
Objectives:	The course aims to provide adequate knowledge about • The detail structure and functions of biological membrane and different cellular organelles • The mechanisms of cellular transport and trafficking • Basic mechanisms of cell division, cell cycle, cancer and fundamental ideas about signaling associated with cellular metabolism • In depth knowledge about cell death and aging	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Comprehend the significance of all the cellular organelles and the deleterious consequences of malfunctioned organelles and how some organelles are absolutely necessary for cellular trafficking and transport.(KI, K2, K5,A1, A2) **CO2:** The fundamental units of cytoskeleton and their role in cell movement Molecular mechanisms of cell cycle, cell division and checkpoints.(K1,K2,A1.A2) **CO3:** Basic signaling require for the cellular metabolisms and their associated consequences with special emphasis on understanding of signaling associated with cell death, senescence and aging. (K1,K2, K5,A1.A2) **CO4:** General idea about cancer development and role of tumor suppressor. (K1,K2,A1.A2)	
Unit I	**Unit I: Dynamic Organization of cell** Universal features of cells; chemical organization of cells; internal organization of the cell - structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum (UPR and ER stress) and Golgi apparatus, lysosomes (lysosomal membrane potential, Lysosomal storage diseases) and peroxisomes, ribosomes, mitochondria (fission and fusion, aging, maternal inheritance), chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes.	
Unit II	**Unit II: Cellular Transport and Trafficking** Membrane transport; Ways to move molecules across membranes; carrier proteins, Ion channels; Muscle contraction and nerve impulse transmission; Nuclear transport (export and import), transport across mitochondria and chloroplasts; Vesicular trafficking in the secretory and endocytic pathway, transport from the ER through the Golgi apparatus, trans-golgi network to the cell surface, exocytosis, molecular mechanism of vesicular transport, protein modification in the secretory pathway.	
Unit III	**Unit III: Cell Junctions** Cell matrix interactions, Adhesion junction, Tight junctions, Gap junctions – disease relevance.	
Unit IV	**Cytoskeleton and Cell movement**	

	Microtubules, intermediates filaments, actin filaments. Microtubule and Actin filament Dynamics, Mechanism of muscle contraction. Motors and movements, function of motor proteins, Cilia & Flagella.
Unit V	**Cell Cycle and its Regulation** Cell division: mitosis, meiosis and cytokinesis; Yeast and molecular genetics of cell cycle control, cell division control in multicultural animals, roles of cyclins, cdks, phosphatases, protein degradation as mechanisms controlling the unidirectional cell cycle.
Unit VI	**Cell Signalling** Molecular mechanism of signal transduction. Integration of signals, second messengers. G Protein Signaling, Ras, RTK, PI3K , TGF-β and Wnt signaling.
Unit VII	**Cell Death and Aging** Apoptosis, necrosis and programmed cell death and the role of the mitochondria and caspase signaling in these processes, Hayflick limits, function of telomerase, autophagy.
Unit VIII	**Molecular Oncology** Causes of cancer. Cancer related genes, including oncogenes and tumor suppressor genes; their normal cellular function, mutagenesis and consequences of their mutant state in cancer. Hereditary cancer. The stepwise transformation process.
Text Books	1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science. 2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
Reference Books	3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning. 4. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland. 5. Weinberg, Robert A. The Biology of Cancer, New York : Garland Science, 2014] - 876, 6, 30, 28
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Blackboard, Power point presentation and tutorial assignment.
Supplementary academic support	guide students to get online materials, providing you tube link, providing review articles on relevant topics etc.
Other learning activities	Discussion, consulting problems.
Supporting Laboratory course	SC/BT/PG/186L: Biophysics and Cell Biology Laboratory
Recommended	February 13, 2020

by the Board of Studies on	
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/131T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	3	3			2								3	1	2	
	CO2	3	3											3	2	2	
	CO3	3	3											3	2	3	
	CO4	3	2											3	2	3	

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/132T: Biochemistry

Course code and Name:	**SC/BT/PG/132T, Biochemistry**	**L T P C** **3 0 0 3**
Course Prerequisites	**Basic Knowledge in Chemistry**	
Objectives:	The course aims to provide adequate knowledge about • Basic principles involved in the chemical basis of life • Fundamentals of protein structure and function. • Principles of Enzyme kinetics	
Course Outcome:	On completion of the course, the students will be able to CO1: Understand essential philosophies involved in elements of life (K2, A1) CO2: Recognize the mechanistic insight of the structure and function relationship of proteins (K2, K3, A4, A5) CO3: Familiarize with the basic principles of enzyme kinetics (K1, K2, K4, A1, A4) CO4: Comprehend the diversity of biological macromolecules (K1, K3, K4, K5, A5)	
Unit I	**Unit I: Chemical basis of life** Chemical basis of life: Miller-Urey experiment, abiotic formation of amino acid oligomers, composition of living matter; Water – properties of water, essential role of water for life on earth pH, buffer, maintenance of blood pH and pH of gastric juice, pH optima of different enzymes (pepsin, trypsin and alkaline phosphatase), ionization and hydrophobicity, emergent properties of biomolecules in water, biomolecular hierarchy, macromolecules, molecular assemblies.]	
Unit II	**Unit II: Protein structure** Structure-function relationships: amino acids – structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, Ramachandran plot, evolution of protein structure, protein degradation and introduction to molecular pathways controlling protein degradation, structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin *etc.*; basic principles of protein purification; tools to characterize expressed proteins; Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation.	
Unit III	**Unit III: Enzyme kinetics** [Enzyme catalysis – general principles of catalysis; quantitation of enzyme activity and efficiency; enzyme characterization and Michaelis-Menten kinetics; relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; single substrate enzymes; concept of catalytic antibodies; catalytic strategies with specific examples of proteases, carbonic anhydrases, restriction enzymes and nucleoside monophosphate kinase; regulatory strategies with specific example of hemoglobin; isozymes; role of covalent modification in enzymatic activity; zymogens.]	
Unit IV	**Unit IV: Glycobiology** [Sugars - mono, di, and polysaccharides with specific reference to glycogen, amylose and cellulose, glycosylation of other biomolecules - glycoproteins and glycolipids; lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.]	
Unit V	**Unit V: DNA RNA Lipids** Self-assembly of lipids, micelle, biomembrane organization - sidedness and function;	

	membrane bound proteins - structure, properties and function; transport phenomena; nucleosides, nucleotides, nucleic acids - structure, a historical perspective leading up to the proposition of DNA double helical structure; difference in RNA and DNA structure and their importance in evolution of DNA as the genetic material.
Text Books	**Recommended Text Books/References** Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman. Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth.
Reference Books	Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons. Dobson, C. M. (2003). *Protein Folding and Misfolding*. Nature, 426(6968), 884-890. doi:10.1038/nature02261. Richards, F. M. (1991). *The Protein Folding Problem*. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	SC/BT/PG/185L Microbiology and Biochemistry Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		1								1	3	3	1	
CO2	3	2		1								1	3	3	1	
CO3	3	2		1								1	3	3	1	
CO4	3	3		1								1	3	3	1	

CO1: Understand the chemical basis of life (K2, A1)
CO2: Recognize the structure function relationship of proteins. (K2, K3, A4, A5)
CO3: Understand how enzymes functions and can be regulated (K1, K2, K4, A1, A4)
CO4: Understand fundamental principles of biomolecules (K1, K3, K4, K5, A5)

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/133T: Fundamentals of Molecular Biology and Microbial Genetics

Course code and Name:	**SC/BT/PG/231T, Fundamentals of Molecular Biology and Microbial Genetics**	**L T P C** **3 0 0 3**
Course Prerequisites	**Basic Knowledge in Biology**	
Objectives:	The course aims to provide adequate knowledge about • Basic principles involved in the Replication and Expression of prokaryotic Genome and its regulation. • Fundamentals of microbial genetics with emphasis of different types of gene transfer and yeast genetics with the emphasis of genetic screening and analysis. • Mutation, their analyses and uses in genetic screening and analysis.	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Understand essential philosophies involved in Eukaryotic DNA Replication. (K2, A1) **CO2:** Recognize the mechanistic insight into the pipelines of eukaryotic gene expression and its regulation. (K2, K3, A4, A5) **CO3:** Familiarize with the basic principles of genetics. (K1, K2, K4, A1, A4) **CO4:** Comprehend and solve diverse problems of genetics (K1, K3, K4, K5, A5)	
Unit I	**Fundamental Concepts: Biomolecular Structures** Physical Chemistry of Chemical Bonds, Concept of Free Energy, Activation Energy and Coupling of Biochemical Reactions, Week and High Energy Bonds in Biological System, Structure and properties of DNA, DNA re-association kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density, Structure and properties of RNA, Functional and Catalytic RNAs and Ribozymes, structure of Amino Acids, peptides and proteins.	
Unit II	**Genome Organization** Organization of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and euchromatin, Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.	
Unit III	**Genome Replication and Maintenance** **DNA Replication:** Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single-stranded circular DNA. **DNA Repair:** Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test), DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair. **DNA Recombination:** Recombination: Homologous and non-homologous; Site specific-recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.	
Unit IV	**Genome Expression** **Prokaryotic Transcription:** Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons. Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA **Prokaryotic Translation:** Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination.	
Unit V	**Bacterial mutants and mutations:**	

	Isolation of mutations; useful phenotypes (auxotrophic; conditional lethal; resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Genetic Analyses in Bacteria and Fungi. **Gene transfer in bacteria:** Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping. **Bacteriophages:** Bacteriophage – structure; assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; History; Transduction – generalized and specialized. **Yeast Genetics:** Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.
Text Books	1) 2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007. 2) Molecular Genetics of Bacteria, By Larry Snider and Wendy Champness, 2007
Reference Books	1) Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007. 2) Bruce Alberts Molecular Biology of the Cell, 4th edition, Garland, 2002. 3) Robert Weaver, Molecular Biology 4) Genomes, by T.A. Brown, Garland Science, 3rd Edition, 2006 7. iGenetics: A Molecular Approach, By Peter J. Russell, 2009.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant You tube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	SC/BT/PG/386L:Molecular Biology and Recombinant Technology Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/133T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	3	2		1								1	3	3	1	
	CO2	3	2	1	1								1	3	3	1	
	CO3	3	2	1	1								1	3	3	1	
	CO4	3	3	3	1								1	3	3	1	

CO1: Understand fundamental principles involved in DNA/RNA/Protein Structures (K2, A1)
CO2: Recognize how Genomes are organized, replicate, and undergo repair and recombination. (K2, K3, A4, A5)
CO3: Understand and describe how genes express and how it is regulated. (K1, K2, K4, A1, A4)
CO4: Understand fundamental principles of molecular genetics and solve elementary and complex problems on bacterial, phage and yeast genetics (K1, K3, K4, K5, A5)

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/134T: Biomathematics, Biostatistics and Computer

Course code and Name:	**SC/BT/PG/134T, Biomathematics, Biostatistics and Computer**	**L T P C** **3 0 0 3**
Course Prerequisites	**Basic knowledge in Mathematics**	
Objectives:	The course aims to provide adequate knowledge about To get introduced to the basic concepts and simple calculations in algebra and calculus. • To get introduced to the basic concepts in samples and compare observed data; comprehensive knowledge on data collection, presentation of data, pictorial representation, and measures of central tendency, measures of dispersion, control charts, correlation, estimation, and inference. • To make students understand and practice beginning and advanced skills in the areas of computer command line mode operations	
Course Outcome:	On completion of the course, the students will be able to **CO1**: Understand the concept of ordinary differential equations, and first and second-order linear differential equations, f analytic geometry and vector algebra. **CO2:** Analyze and interpret data using appropriate statistical hypothesis and parametric testing techniques. **CO3**: Know the importance of the bash environment and awareness on command line operations.	
Unit I	**Algebra** Linear equations, functions: slopes-intercepts, forms of two-variable linear equations; constructing linear models in biological systems; quadratic equations (solving, graphing, features of, interpreting quadratic models etc.), introduction to polynomials, graphs of binomials and polynomials; Symmetry of polynomial functions, basics of trigonometric functions, Pythagorean theory, graphing and constructing sinusoidal functions, imaginary numbers, complex numbers, adding-subtracting-multiplying complex numbers, Basics of vectors, Introduction to matrices. Linear programming. Nature of the roots of an algebraic equation, multiple roots, Descartes' rule of signs; Algebra of matrices, adjoint and inverse of a matrix, rank of a matrix, matrix method of solution of a system of linear equations, consistency of a system of equations, solution of linear equations.	
Unit II	**Calculus** Differential calculus (limits, derivatives), integral calculus (integrals, sequences and series etc.). Successive differentiation, partial differentiation, integration. Differential equation of first and second order, Applications of first and second order differential equations, Systems of linear differential equations and its applications, partial derivatives, formation of partial differentiation equations and their solutions.	
Unit III	**Bio-Statistics** Probability: counting, conditional probability, discrete and continuous random variables; Distributions (Binomial, Normal and Poisson) Error propagation; Fitting a curve to an experimental data set -- linear and non-linear fits. Populations and samples, expectation, parametric tests of statistical significance, nonparametric hypothesis tests, linear regression, correlation & causality, analysis of variance, factorial experiment design.	
Unit IV	**Computer** Introduction of Digital computers: organization of low- and high-level languages binary number system.	

	Flowcharts and programming techniques. Solutions of differential equations, phase plane analysis, bifurcation analysis, sensitivity analysis and parameter estimation using MATLAB. Perl/R programming and their application in biological sciences, sequence, strings, motifs and loops subroutines and bugs, mutation and randomization genetic code, restriction maps.
Text Books	1) Stroud, K. A., & Booth, D. J. (2009). Foundation Mathematics. New York, NY: Palgrave Macmillan 2) Aitken, M., Broadhursts, B., & Haldky, S. (2009) Mathematics for Biological Scientists. Garland Science.
Reference Books	1. Billingsley, P. (1986). Probability and Measure. New York: Wiley. 2. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press. 3. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences, New York: Wiley
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily black board teaching, Power Point presentation, and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	Hands on training tutorials for each of the class
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3	PSO4
CO1	3	3	3	2	3			2	1		2			2	2	
CO2	3	3	3	2	3			2	1		2			2	2	
CO3	3	3	3	3	3			2	1		2			2	2	

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							

SC/BT/PG/186L: Microbiology and Biochemistry Laboratory

Course code:	**SC/BT/PG/186L : Microbiology and Biochemistry Laboratory**	**L T P C** **0 2 6 8**
Course Prerequisites	**Basic Knowledge in Microbiology and Biochemistry**	
Objectives:	The course aims to provide adequate knowledge about • Hands on knowledge on Biochemistry and Microbiology	
Course Outcome:	On completion of the course, the students will be able to **CO1**: Understand, and adapt with basic principles involved in biochemical and microbial techniques and familiar with the instrumentations (K2, A4). **CO2**: Get exposed to the basic methods of protein estimation and enzyme assay (K2, K3, A4). **CO3:** Conduct elementary experiments involving growth and enumeration of bacteria in soil , water (A4, S4, S5).	
Unit I	**Practical Microbiology** 1. Sterilization, disinfection and safety in microbiological laboratory. 2. Preparation of media for cultivation of bacteria. 3. Isolation of bacteria in pure culture by streak plate method. 4. Study of colony and growth characteristics of some common bacteria: *Bacillus, E. coli, Staphylococcus, Streptococcus, etc.* 5. Preparation of bacterial smear and Gram's staining. 6. Enumeration of bacteria: standard plate count. 7. Antimicrobial sensitivity test and demonstration of drug resistance. 8. Maintenance of stock cultures: slants, stabs and glycerol stock cultures 9. Determination of phenol co-efficient of antimicrobial agents. 10. Determination of Minimum Inhibitory Concentration (MIC) 11. Isolation and identification of bacteria from soil/water samples.	
Unit II	**Biochemistry** 1. Preparing various stock solutions and working solutions that will be needed for the course. 2. To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation. 3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer-Lambert's Law. 4. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography. 5. Purification of an enzyme using some of the following techniques: a) Ammonium Sulfate precipitation b) Ion-exchange Chromatography c) Gel Filtration d) Affinity Chromatography e) Dialysis of the purified protein solution against 60% glycerol as a demonstration of storage method 6. Characterization of the purified Enzyme:	

	a) Generating a Purification Table (protein concentration, amount of total protein; Computing specific activity of the enzyme preparation at each stage of purification) b) Assessing purity of samples from each step of purification by SDS-PAGE Gel Electrophoresis c) Enzyme Kinetic Parameters: K_m, V_{max} and K_{cat}. 7. Absorption Spectroscopy for native and Denatured DNA.
Text/Reference Books	1) 2)
Mode of Evaluation	Continuous Evaluation followed by Final-Viva voce at the End Term Examination
Course delivery format	Lecture followed by hand-on experiment.
Supplementary academic support	
Other learning activities	
Supporting Laboratory course	Not Applicable
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/186L		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	2	2	2	2	3	2		1	1	1		1	3	3	2
	CO2	2	2						1	1	1		2	3	3	2
	CO3		3	3	3	1			1	1	1		1	3	3	3

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

MSBT146L: Biophysics, Cell Biology and Genetics Laboratory

Course code and Name:	**SC/BT/PG/186L, Biophysics, Cell Biology and Genetics Laboratory**	**L T P C** **0 2 6 8**
Course Prerequisites	**Basic knowledge in Biology**	
Course Outcomes:	On completion of the course, the students will be able to **CO1**: Understand, and adapt with basic principles involved in biophysical techniques and familiar with the biophysical instrumentations (K2, A4). **CO2**: Get exposed to the basic methods of genetics and cell biology (K2, K3, A4). **CO3:** Conduct elementary experiments involving biophysical, genetic and cell biological techniques (A4, S4, S5).	
Unit-I	**Biophysics** 1. Introduction to UV-Spectrophotometer, validation of the Beer- Lambert's Law, Analysis of absorption spectrum of DNA, RNA and Protein, Spectrophotometric quantification of DNA, RNA and Protein at specific wavelength and analysis of their quality. 2. Spectrophotometric Analysis of interaction between DNA and Ethidium Bromide. 3. Spectrophotometric Analysis of interaction between Haemoglobin-Na-Azide interaction. 4. Spectrophotometric study of protein unfolding/denaturation kinetics using myoglobing as a model protein. 5. Titration of Acetic Acid and Amino Acid glycine-HCl using pH meter. 6. Identification of an unknown sample as DNA, RNA or protein using available laboratory tools. 7. Purification and separation of a mixture of proteins in Gel Filtration Chromatography 8. Biophysical methods Fluorescence Spectroscopy 9. Spectrofluoremetric Analysis of interaction between DNA and Ethidium Bromide. 10. Spectrofluoremetric Analysis of interaction between BSA-acrylamide.	
Unit-II	**Cell Biology** 1. Cell Viability assay and determination of proliferation indices in cultured mammalian cell. 2. Immunohistochemistry of tissue section. 3. Monitor and measure doubling time of animal cells. 4. Examination of chicken embryo at different developmental stages in presence of stress.	
Unit-III	**Genetics** 1. Microscopic observation of yeast mating reaction eg. smoo formation, crown (diploid yeast cell) and spore formation. 2. Determination of UV-survival curve of Yeast *Saccharomyces cerevisiae followed by* UV mutagenesis to isolate amino acid auxotroph. 3. Genetic Transfer-Conjugation, gene mapping.	
Text/Reference Books	1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982. 2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.	
Recommended by the Board of	February 13, 2020	

Studies on	
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/186L		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	2	2	2	2	3	2		1	1	1		1	3	3	3	2
	CO2	2	2	2	2	3	2		1	1	1		2	3	3	3	2
	CO3		3	3	3	3	1		1	1	1		1	3	3	3	3

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

Semester II

SC/BT/PG/231T: Advanced Molecular Biology and Genetics

Course code Name:	**SC/BT/PG/231T, Advanced Molecular Biology and Genetics**	**L T P C** **3 0 0 3**
Course Prerequisites	**SC/BT/PG/231T, Fundamentals of Molecular Biology and Microbial Genetics**	
Objectives:	The course aims to provide adequate knowledge about • Fundamental doctrines of the eukaryotic molecular biology including replication and Expression of Eukaryotic Genome and its regulation. • Fundamentals of mendelian/non-medelian (classical) genetics covering higher eukaryotic domains. • Principles of Cytogenetics, Developmental and Population Genetics.	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Understand essential philosophies involved in Eukaryotic DNA Replication. (K2, A1). **CO2:** Recognize the mechanistic insight into the pipelines of eukaryotic gene expression and its regulation. (K2, K3, A4, A5). **CO3:** Familiarize with the basic principles of genetics. (K1, K2, K4, A1, A4). **CO4:** Comprehend and solve diverse problems of molecular biology and genetics (K1, K3, K4, K5, A5).	
Unit I	**Eukaryotic DNA Replication** Eukaryotic Chromosome Replication and its tight-coupling with the Cell Cycle, initiation of Eukaryotic DNA replication, regulation of eukaryotic DNA replication during cell cycle. Elongation and termination of the eukaryotic replication, problem associated with the ends of the linear chromosome.	
Unit II	**Eukaryotic Transcription, mRNA processing and Post-transcriptional Modification** Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing.	
Unit III	**Nuclear mRNA Biogenesis and Post Transcriptional Modifications of Pre-Messenger RNA (4 Lectures):** Processing of Ribosomal and transfer RNAs, Co- and post-translational modifications of messenger RNAs; Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.	
Unit IV	**Eukaryotic Translation**	

	Features of mRNA template, Ribosomes, Translation termination, Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation
Unit V	**Regulation of Gene Expression in Eukaryotes** Conserved mechanism of transcriptional regulation from yeast to human, Recruitment of the protein complex to the genes by eukaryotic activators, Signal integration and combinatorial control, transcriptional repressors, Signal transduction and the control of transcriptional regulators, Epigenetic regulation, regulatory RNAs in eukaryotes – miRNAs, biogenesis and function, Long non-coding RNAs and their role in gene regulation in eukaryotic system
Unit VI	**Mendelian Genetics** Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance - autosomal recessive; autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases, Genome polymorphism; uses of polymorphism, Physical mapping; linkage and association
Unit VII	**Non Mendelian inheritance patterns** Mitochondrial inheritance; genomic imprinting; Lyon hypothesis; isodisomy. Complex inheritance – genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits
Unit VIII	**Cytogenetics** Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes.
Unit IX:	**Developmental Genetics** Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; and Signaling and adhesion molecules.
Unit X	**Population genetics and evolution** Gene frequency; Hardy-Weinberg law; Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift. Human genetic diversity; Origin of major human groups.
Text Books	1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Bartlett Publishers, 2007. 2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007. 3. Robert Weaver, Molecular Biology, 5th Edition, McGraw-Hill, 2012. 4. Molecular Genetics of Bacteria, By Larry Snider and Wendy Champness, 2007. 7. Genomes, by T.A. Brown, Garland Science, 3rd Edition, 2006. 8. iGenetics: A Molecular Approach, By Peter J. Russell, 2009.

	10. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, William M. Gelbart, David T. Suzuki, Jeffrey H. Miller, An Introduction to Genetic Analysis, Eleventh Edition.
Reference Books	11. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principles and Analysis*. Sudbury, MA: Jones and Bartlett. 12. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W.H. Freeman. 13. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown. 14. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching, problem solving at class and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	SC/BT/PG/386L:Molecular Biology and Recombinant Technology Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/231T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	3	2		2	1							1	3	3	1	
	CO2	3	2	1	2	1							1	3	3	1	
	CO3	3	2	2	2	1							1	3	3	1	

	CO4	**3**	**3**	**3**	**2**	**1**							**1**	**3**	**3**	**1**	

CO1: Understand essential philosophies involved in Eukaryotic DNA Replication. (K2, A1)
CO2: Recognize the mechanistic insight into the pipelines of eukaryotic gene expression and its regulation. (K2, K3, A4, A5)
CO3: Familiarize with the basic principles of genetics. (K1, K2, K4, A1, A4)
CO4: Comprehend and solve diverse problems of molecular biology and genetics (K1, K3, K4, K5, A5)

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/232T: Metabolism and Bioenergetics

Course code and Name:	**SC/BT/PG/232T, Metabolism and Bioenergetics**	**L T P C** **3 0 0 3**
Course Prerequisites	**SC/BT/PG/132T, Biochemistry**	
Objectives:	The course aims to provide adequate knowledge about • Basic principles involved in the oxidation of carbon fuels • Fundamentals of photosynthesis and other metabolic pathways • Principles of Bioenergetics	
Course Outcome:	On completion of the course, the students will be able to CO1: Understand essential philosophies involved in fuels of life (K2, A1) CO2: Recognize the mechanistic insight of the photosynthesis(K2, K3, A4, A5) CO3: Familiarize with the basic principles of metabolic pathways (K1, K2, K4, A1, A4) CO4: Comprehend the principles of bioenergetics (K1, K3, K4, K5, A5)	
Unit I	**Unit I: Oxidation of carbon fuels** glycolysis and gluconeogenesis; reciprocal regulations and non-carbohydrate sources of glucose; Citric acid cycle, entry to citric acid cycle, citric acid cycle as a source of biosynthetic precursors; Electron transport chain; Oxidative phosphorylation; importance of electron transfer in oxidative phosphorylation; F1-F0 ATP Synthase; shuttles across mitochondria; regulation of oxidative phosphorylation.	
Unit II	**Unit II: Photosynthesis** Chloroplasts and two photosystems; proton gradient across thylakoid membrane; Calvin cycle and pentose phosphate pathway; glycogen metabolism, reciprocal control of glycogen synthesis and breakdown, roles of epinephrine and glucagon and insulin in glycogen metabolism;	
Unit III	**Unit III: Elucidation and Integration of metabolic pathways** Fatty acid metabolism; Protein turnover and amino acid catabolism; nucleotide biosynthesis; biosynthesis of membrane lipids and sterols with specific emphasis on cholesterol metabolism and mevalonate pathway.	
Unit IV	**Unit IV: Bioenergetics:** Thermodynamics – Mathematical description of thermodynamic functions- first, second and third law-isothermal process, entropy enthalpy reversible and irreversible process; equilibria and concept of free energy; chemical potential, Gibbs free energy; coupled interconnecting reactions in metabolism; The Nernst potential, Donnan equilibrium, Chemical equilibrium involving macromolecules.	
Text Books	1) **Recommended Text Books/References** Stryer, L. (2015). *Biochemistry*. (8th ed.) New York: Freeman. 2)) Lehninger, A. L. (2012). *Principles of Biochemistry* (6th ed.). New York, NY: Worth.	
Reference Books	1Voet, D., & Voet, J. G. (2016). *Biochemistry* (5th ed.). Hoboken, NJ: J. Wiley & Sons.	
Mode of Evaluation	Written Class Test Final-Written Term End Examination	
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.	
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.	
Other learning	Class discussions, Group problem solving sessions, Relate to other courses in the	

activities	curriculum with examples
Supporting Laboratory course	SC/BT/PG/185L Microbiology and Biochemistry Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
SC/BT/PG/232T	CO1	3	2		1								1	3	3	1
	CO2	3	2		1								1	3	3	1
	CO3	3	2		1								1	3	3	1
	CO4	3	3		1								1	3	3	1

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/233T: Immunology

Course code and Name:	**SC/BT/PG/233T, Immunology**	**L T P C** **3 0 0 3**
Course Prerequisites	**Basic knowledge in Biology**	
Objectives:	The course aims to provide adequate knowledge about • Basic understanding about immune cells, their origin and function • Development of ideas on innate and adaptive immune system, generation of diverse immune response. • Development of ideas on different immune response in normal and disease condition	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Understand the role of different immune cells and their function (K1, K2, A1, A2) **CO2:** Fundamental ideas about the development and role of T cell and B cells (K1, K2, K4, A1, A2) **CO3:** Developed ideas on immune dysfunction and their consequences (K1, K2, A1, A2).	
Unit I	**Immunology: fundamental concepts and overview of the immune system** Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility.	
Unit II	**Immune responses generated by B and T lymphocytes: Immunoglobulin** Basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; 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 immuneresponses and Hypersensitivity.	
Unit III	**Antigen processing and presentation** Endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.	
Unit IV	**Immunogenetics** Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.	
Unit V	**Clinical immunology** Transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology:tumor antigens; immune response to tumors and tumor evasion of the immunesystem, cancer immunotherapy; immunodeficiency: primary immunodeficiencies,acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock,immunosenescence, immune exhaustion in chronic viral infection, immune tolerance,NK cells in chronic viral infection and malignancy.	
Text Books	1) Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*.New York: W.H. Freeman.	

	2) Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology*. London: Gower Medical Pub. 3) Abul K. Abbas, Andrew H. H. Lichtman, and Shiv Pillai, Cellular and Molecular Immunology. 9th Edition
Reference Books	1) Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press. 2) Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology*. London: Academic Press
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	SC/BT/PG/385L **Immunology Laboratory**
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/233T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	3	3		1									3	3	3	3
	CO2	3	3		2									3	3	3	3
	CO3	3	3	2	2									3	3		

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/234T: Microbiology

Course code and Name:	**SC/BT/PG/234T, Microbiology**	**L T P C** **3 0 0 3**
Course Prerequisites	**Basic knowledge in Biology**	
Objectives:	The course aims to provide adequate knowledge about • Basic principles involved in the study of microbial life • Fundamentals of structure and function relationship of bacterial body parts • Development of ideas on different microbial properties	
Course Outcome:	On completion of the course, the students will be able to CO1: Understand essential philosophies involved in microbial life (K2, A1) CO2: Recognize the mechanistic insight of the structure and function relationship of microbial body parts (K2, K3, A4, A5) CO3: Familiarize with the basic principles of microbial growth and its implication (K1, K2, K4, A1, A4) CO4: Comprehend the diversity of microbes including virus (K1, K3, K4, K5, A5)	
Unit I	**Unit I** History of Microbiology or Development of microbiology as a scientific discipline. Methods of studying microorganisms.	
Unit II	**Unit II** Organization and structure of microbes (Morphology of bacteria, yeast and molds, algae, protozoa, virus, prions) [Microbial morphology: capsule, slime layer, pili, flagella cell wall, matrix material, chemotaxis].	
Unit III	**Unit III** Bacterial growth and reproduction [Physical and chemical requirement Energy metabolism Autotroph, Phototroph, Lithotroph etc Growth kinetics Specific growth rate Batch Fedbatch and continuous culture Effect of substrate concentration Monod kinetics Definition of Ks Stress response, Classification system Control of microbes by physical and chemical agents].	
Unit IV	**Unit IV** Microbial interactions (Host microbe interaction Koch's postulates Mechanisms of pathogenicity Diseases Antibiotics and their targets, symbiosis, recycling of matters).	
Unit V	**Unit V** Frontiers of Microbiology [Evolution, diversity, Microbes in the extreme environment, Microbes in agriculture Symbiotic Nitrogen fixation , medical biotechnology Industrial Microbiology Food, Secondary metabolites, recombinant products, Environmental Microbiology Waste treatment Xenobiotics Bioremediation , IPR, GMP, GRAS, Process Engineering].	
Unit VI	**Unit VI** Classification and modes of propagation of bacterial (λ, T4, T7, M13, Qβ, φX174) plant (TMV) and animal viruses (HIV, Baculovirus, Adenovirus), Antiviral agents, interferons.	
Text Books	**Recommended Textbooks and References:** 1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). *Microbiology* (5th ed.)., New York: McGraw-Hill. 2. Michael T Madigan and John M Martinko *Brock Biology of Microorganisms* (11th Ed) Prentice Hall	

Reference Books	1) Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). *Prescott's Microbiology*. New York: McGraw-Hill. 2) Matthai, W., Berg, C. Y., & Black, J. G. (2005). *Microbiology, Principles and Explorations*. Boston, MA: John Wiley & Sons.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	SC/BT/PG/185L Microbiology and Biochemistry Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/234T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3	2		1								1	3	3	1
	CO2	3	2		1								1	3	3	1
	CO3	3	2		1								1	3	3	1
	CO4	3	3		1								1	3	3	1

CO1: Understand the development of microbiology as a discipline in science (K2, A1)
CO2: Recognize the structure function relationship of microbial body parts. (K2, K3, A4, A5)
CO3: Understand how microbes grow and how they can be regulated (K1, K2, K4, A1, A4)
CO4: Understand the frontiers of microbiology and the fundamental properties of virus (K1, K3, K4, K5, A5)

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/235T: Bioinformatics

Course code and Name:	**SC/BT/PG/235T, Bioinformatics**	**L T P C** **2 1 0 3**
Course Prerequisites	**SC/BT/PG/134T: Biomathematics, Biostatistics and Computer**	
Objectives:	The course aims to provide adequate knowledge about • To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis. • To use and develop tools to curate (compare &analyze) biological data. • To use and develop bioinformatics programs for comparing &analyzing biological sequence data to identify probable function. • Hands on training in bioinformatics tools	
Course Outcome:	On completion of the course, the students will be able to **CO1**: Basic algorithms used in Pairwise and Multiple alignments. **CO2**: Understanding the methodologies used for database searching, and determining the accuracies of database search. **CO3**: To get exposed to various tools and methodologies used in multiple sequence alignment, phylogenetic analysis and genetic diversity analysis observed in biological sequences. **CO4**: Introduction to the concept of molecular modelling and molecular docking.	
Unit I	**Bioinformatics Basics** Bioinformatics basics: Computers in biology and medicine; Introduction to Unix and Linux systems and basic commands; DNA sequence extraction from chromatogram. Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.	
Unit II	**DNA sequence analysis** DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing. Graph theory and its use in DNA sequence analysis.	
Unit III	**Multiple sequence analysis** Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.	
Unit IV	**Protein modeling**	

	Protein modeling; introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.
Unit V	**Bioinformatics Laboratory** Using NCBI and Uniprot web resources, Introduction and use of various genome databases, Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/TrEMBL, UniProt, Similarity searches using tools like BLAST and interpretation of results, Multiple sequence alignment using ClustalW, Phylogenetic analysis of protein and nucleotide sequences, Use of gene prediction methods (GRAIL, Genscan, Glimmer), Using RNA structure prediction tools, Use of various primer designing and restriction site prediction tools, Use of different protein structure prediction databases (PDB, SCOP, CATH).
Text Books	1) D.W. Mount Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York 2) Xiong J (2006) Essential Bioinformatics. Cambridge University Press, New York
Reference Books	1) Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press. 2) Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience. 3) Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell. 4) Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	Hands on training course after completion of each of the units
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic	December 10, 2020

Council	

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/235T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	3	2	1	3	3				2				3	3	3	
	CO2	3	2	1	3	3				2				3	3	3	
	CO3	3	2	1	3	3				1				3	3	3	
	CO4	3	3	2	3	3				1				3	3	3	

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/236T: Bio-analytical Techniques

Course code and Name:	**SC/BT/PG/236T, Bio-analytical Techniques**	**L T P C** **3 0 0 3**
Course Prerequisites	Basic knowledge of various science subjects	
Objectives:	The course aims to provide adequate knowledge about • The skills to understand the theory and practice of various bio analytical techniques. • To provide scientific understanding of analytical techniques and detail interpretation of results.	
Course Outcome:	On completion of the course, the students will be able to **CO1:** To select a specific analytical technique to measure and analyze biophysical/ biochemical/physiological parameters (K2, K3, K5, A5). **CO2:** Use the skills to employ working principals, tools and techniques of various analytical techniques to design experiments (K3, K4, A5, S5) **CO3:** To understand the strengths, limitations and creative use of techniques for problem-solving (K5, K6, A1).	
Unit I	**Spectroscopy Techniques** Bimolecular spectroscopy - UV, Visible and Raman and Laser Raman Spectroscopy, Vibrational spectroscopy in biology; Polarization in light scattering Theory and application of linear and Circular Dichroism; Emission Spectroscopy: Fluorescence spectroscopy and its application in biotechnology. Determination MS, NMR, Nuclear Magnetic Resonance spectroscopy, PMR, ESR and Plasma Emission spectroscopy	
Unit II	**Chromatography Techniques** TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity.	
Unit III	**Electrophoresis Techniques** Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.	
Unit IV	**Centrifugation** Basic principles & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.	
Unit V	**Radioactivity** Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop	

	method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay, Radiation Safety.
Unit VI	**Microscopy** Basic concept of light microscope., Fluorescence microscopy, Confocal, AFM, DIC, Photon microscopy, TEM, SEM, HRSEM, FACs analysis.
Unit VI	**Advanced Techniques:** X-ray Crystallography - Theory and methods; Protein and DNA X-ray Crystallography, API-electrospray and MADI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.
Unit VII	**Immunotechniques** ELISA, Immunoprecipitation, diagnosis of infectious diseases, respiratory diseases (influenza etc), Viral diseases –HIV etc, bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases, Phage display, immunoarrays. FACs immunocytochemical staining, ELISA for detection of Salmonella in food, ELISA, FACS, FISH techniques. Immunofluorescence technique - Immunoblot analysis of antigens and allergens.
Text Books	1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982. 2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000. 3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998. 4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994. 7. Immunodiagnostic Technology and its Applications, Didier Levieux, 2007
Reference Books	1. Selected readings from Methods in Enzymology, Academic Press. 2. Biophysics: Tools and Techniques. Mark C. Leake,, CRC Press , 2016. 3.Van Holdee, K.E., Johnson, W. C., and Ho, P.S. Principles of Physical Biochemistry, Prentice-Hall International.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting	MSBT146L: Biophysics, Cell Biology and Genetics Laboratory

Laboratory course	MSBT145L: Microbiology and Biochemistry Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/236T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO3
	CO1	2	3	3	3	3	3			1	1		1	3	3	3	1
	CO2	2	3	3	3	3	3			1	1		1	3	3	3	1
	CO3	2	3	3	3	3	1						1	3	3	3	1

CO1: To select a specific analytical technique to measure and analyze biophysical/ biochemical/physiological parameters (K2, K3, K5, A5).
CO2: Use the skills to employ working principals, tools and techniques of various analytical techniques to design experiments (K3, K4, A5, S5)
CO3: To understand the strengths, limitations and creative use of techniques for problem-solving (K5, K6, A1).

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

Semester III

SC/BT/PG/331T: Recombinant DNA Technology

Course code and Name	**SC/BT/PG/331T, Recombinant DNA Technology**	**L T P C** **3 0 0 3**
Course Prerequisites	**SC/BT/PG/133T Fundamentals of Molecular Biology and Microbial Genetics** **SC/BT/PG/231T Advanced Molecular Biology and Genetics**	
Objectives:	The course aims to provide adequate knowledge about • Different tools used to manipulate nucleic acids in Recombinant DNA Technology • In depth knowledge about several techniques used in Recombinant DNA Technology • Thorough idea about how to apply these tools and techniques of Recombinant DNA Technology to better understand basic and translational biology.	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Gather knowledge to manipulate nucleic acids in Recombinant DNA Technology (K1, K2, K3, A1, A2) **CO2:** Acquire in depth knowledge about several techniques used in Recombinant DNA Technology (K1, K2, K3, A1, A2) **CO3:** Apply these tools and techniques of Recombinant DNA Technology to better understand different aspects of basic and translational biology (K1, K2, K3, K4, A1, A2, A4)	
Unit I	**Tools of Recombinant DNA Technology** **1. DNA & RNA manipulating enzymes and other tools used in Recombinant DNA Technology**: Restriction endonuclease, DNA polymerases (DNA Pol I, T4, T7, Taq), reverse transcriptase, DNA ligase, Alkaline Phosphatase, Polynucleotide kinase, Terminal Deoxy-nucleotidyl transferase, Topoisomerases, DNase, RNase and others, linkers and adapter, Restriction-modification systems. **2. Cloning Vectors:** Natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid. **3. Restriction-modification systems:** History; types of systems and their characteristics; Methylation-dependent restriction systems; applications, M13 mp vectors; pUC19 and Bluescript vectors. **4. Bacteriophages:** Phagemids, Lambda vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/ bacculo & retroviral vectors; Expression vectors; pMal; GST; pET basedvectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; I nclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	
Unit II	**Techniques of Recombinant DNA Technology** **1. Basic methods of Molecular Biology:** Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Western Blot, Chromatin Immunoprecipitation; DNA-	

	Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay; RAPD, RFLP, AFLP, PFGE. **2. PCR and Its Applications***:* Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Molecular markers, Viral and bacterial detection; PCR based mutagenesis. **3. Sequencing methods:** Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Emulsion and bridge PCR; 454 pyrosquencing, (SOLiD) sequencing, Solexa Illumina sequencing, RNA sequencing. Restriction Mapping and Site directed mutagenesis
Unit III	**Gene Cloning Methods** **1. Cloning Methodologies:** Isolation and preparation of DNA fragments from prokaryotic and eukaryotic source. Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression. Different types of cloning and expression methods of gene in prokaryotic and eukaryotic host cell system using different vectors (by restriction enzyme, PCR product cloning and other methods). Screening and Expression of cloned gene. Subcloning strategies.
Unit IV	**Application of Recombinant DNA Technology** Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array; stem cells; induced pluripotent stem cells (iPS cells); Therapeutic approach of iPS cells; CRISPR-Cas9 system.
Text Books	1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications. 2. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
Reference Books	3. Brown, T. A. (2006). Genomes (3rd ed.) New York: Garland Science Pub. 4. Selected papers from scientific journals, particularly Nature & Science. 5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
Mode of Evaluation	Written Class Test Final-Written Term End Examination

Course delivery format	Blackboard, Power point presentation and tutorial assignment
Supplementary academic support	guide students to get online materials, providing you tube link, providing review articles on relevant topics etc
Other learning activities	Discussion, consulting problems
Supporting Laboratory course	SC/BT/PG/386L, Molecular Biology and Recombinant Technology Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
SC/BT/PG/331T	CO1	3	3	3	2									3	3	3	
	CO2	3	3	2	2									3	3	2	
	CO3	3	3	3	2									3	3	2	

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/332T: Genomics and Proteomics

Course code:	**SC/BT/PG/332T Genomics and Proteomics**	**L T P C** **3 0 0 3**
Course Prerequisites	**SC/BT/PG/133T Fundamentals of Molecular Biology and Microbial Genetics** **SC/BT/PG/231T Advanced Molecular Biology and Genetics** **SC/BT/PG/132T Biochemistry**	
Objectives:	The course aims to provide adequate knowledge about • Principles of basic methods of genomic, transcriptomic and proteomic analysis. • Extensive knowledge of various methodologies of next generation sequencing and Mass spectroscopic, and microarray technologies • Crucial concepts and techniques applied in genomics, transcriptomics and proteomics.. • Formulate and assess experimental design for solving theoretical and experimental problems in Genomics and Proteomics fields.	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Inferring the basic concepts of genomics, transcriptomics and proteomics (K2, K4, K5, A5). **CO2:** Suggesting and outlining solution to theoretical and experimental problems in Genomics, Transcriptomics and Proteomics fields. (K3, K4, K5, A4, A5) **CO5:** Comprehend and solve diverse problems of genomics. transcriptomics and proteomics in human welfare, health and disease (K3, K4, K5, K6, A4, A5).	
Unit I	**Basics of genomics and proteomics** Brief Recapitulation of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.	
Unit II	**Genome mapping** Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.	
Unit III	**Genome Sequencing Projects and Genomic Techniques and Tools** Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web, Vectors for large scale genome projects, Clone-by-clone strategy, shotgun sequencing and Sequencing Standards	
Unit IV	**Comparative genomics** Identification and classification of organisms using molecular markers- 16S rRNA typing/ sequencing, SNPs and Pharmacogenomics; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence, Human and other vertebrate Genome, Personal genomics, The minimal genome and the Barcode of Life.	
Unit V	**Functional Genomics** Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics; protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics; introduction to metabolomics, lipidomics, metagenomics and systems biology.	
Unit VI	**Proteomics**	

	Aims, strategies and challenges in proteomics; Protein separations, protein analyses, Quantitative proteomics, Identification and analysis of proteins by 2D gel electrophoresis, Isoelectric focusing, Spot visualization and picking, Tryptic digestion of protein and peptide fingerprinting; Mass spectrometry, mass spectrum (base peak, molecular ion, fragment ion, metastable ion), Ion source (MALDI, electrospray, chemical ionization), mass analyzer (quadrupole, TOF, Ion trap) ; Detector (multiplier), Clinical proteomics, Protein-protein interaction: solid ELISA, pull-down assay, co-immunoprecipitation, yeast-two hybrid system, application, proteome databases.
Text Books	1. Robert Weaver, Molecular Biology, 5th Edition, McGraw-Hill, 2012. 2. Genomes, by T.A. Brown, Garland Science, 3rd Edition, 2006 3. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, William M. Gelbart, David T. Suzuki, Jeffrey H. Miller, An Introduction to Genetic Analysis, Eleventh Edition, 4. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006) Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
Reference Books	1. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press. 2. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Primarily Power Point presentation, black board teaching, problem solving at class and tutorial assignments.
Supplementary academic support	Providing links to online courses/sites, providing additional learning materials from practical applications, providing relevant Youtube videos.
Other learning activities	Class discussions, Group problem solving sessions, Relate to other courses in the curriculum with examples
Supporting Laboratory course	SC/BT/PG/386L:Molecular Biology and Recombinant Technology Laboratory
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/133T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	CO1	2	3	3	3	3							2	3	3	2	1
	CO2	3	3	3	3	3							2	3	3	2	1
	CO3	3	3	3	3	3	2			1	1		2	3	3	2	1

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/GE/333T: Plant and Microbial Biotechnology

Course code:	**SC/BT/PG/GE/333T, Plant and Microbial Biotechnology**	**L T P C** **6 0 0 6**
Course Prerequisites	**SC/BT/PG/131T Cell Biology** **SC/BT/PG/234T Microbiology**	
Objectives:	The course aims to provide adequate knowledge about • In depth knowledge about plant embryogenesis, transformation and chloroplast transformation • Detailed concept on development plant biotechnology • Thorough understanding of the isolation and identification of important microbial strains. • The different aspects of bioremediation	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Gather knowledge about plant cell culture and transformation (K1, K2, K3, A1, A2) **CO2:** Acquire in depth knowledge about several techniques used in Recombinant DNA Technology for use of plant biotechnology (K1, K2, K3, A1, A2) **CO3:** Understand the detailed methods of microbial strain isolation and use of them in bioremediation (K1, K2, K3, K4A1, A2, A4)	
Unit I	**Unit I:** Reporter genes, Gene transfer and selection of regenerated transformed plantlets through embryognenesis or multiple shoot emergence. Chloroplast transformation: techniques, relative advantages over nuclear transformation. Determination of copy number: multiple insertion events.	
Unit II	**Unit II:** Applications of Plant Biotechnology: Biopesticides, Bt toxins and their biology, structure and mode of action of different Bt toxin in relation to host range specificity and toxicity, Other insecticide proteins - characteristic mode of action. Disease resistance genes and their biological use. Metabolic engineering for stress tolerance, nutritional improvement, flower colour and other agronomically important characters. Virus mediated expression of protein regulation of gene expression in plants. Plants as bioreactors. Plant genomics. Importance of Arabidopsis thaliana as a model plant. Molecular markers in plant genomic analysis. Plant virus: RNA and DNA genome and their expression. Importance as vector.	
Unit III	**Unit III:** Isolation , identification and selection of microbial strains. Strain improvement to increase product formation. Maintenance and preservation of microbial cultures. Aerobic and anaerobic carbon utilization: renewable and nonrenewable substrates.	
Unit IV	**Unit IV:** Waste management: treatment of solid and liquid waste. Bioremediation of xenobiotic compounds. Microbial enzyme production. Microbial fuel and chemical production. Food production involving microbes. Secondary metabolite production. Microbial recovery of metals.	
Text Books	**Recommended Textbooks and References**: 1. Glazer and Mikado: Microbial Biotechnology, Fundamentals of Applied Microbiology (Freeman) 2. Algae-Anatomy, Biochemistry and biotechnology-L. Barsanti& P. Gualtieri. Taylor & Francis, 2006.	

	3. Biotechnology and Plant Disease Management Edited by Zamir K. Punja, S. H. De Boer, Hélène Sanfaçon. CAB Direct. 4. Biotechnology and Plant Breeding, 1st Edition (2014), by Borém & Fritsche-Neto (Elsevier).
Reference Books	1. L E Casida , Jr: Industrial Microbiology (New Age Intl Pub) 2. Prescott & Dunn's: Industrial Microbiology (4th Ed) (REED) 3. Manual of Industrial Microbiology and Biotechnology (ASM Press), 2nd Ed: Demain & Davis editors in chief. 4. Plant Biotechnology and Agriculture by Arie Altman and PM Hasegawa (Elsevier 2012). 5. Plant Stress and Biotechnology by by Devarajan Thangadurai, Wei Tang, and Song-Quan Song, Oxford Book Co.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Blackboard, Power point presentation and tutorial assignment
Supplementary academic support	Guide students to get online materials, providing you tube link, providing review articles on relevant topics etc
Other learning activities	Tutorial with discussion, consulting problems
Supporting Laboratory course	**SC/BT/PG/186L: Microbiology and Biochemistry Laboratory**
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/331T		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
	CO1	3	3	2		1								3	3	2	
	CO2	3	3	3		1								3	3	2	
	CO3	3	3	2		1								3	3	1	

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/GE/363T: Animal and Developmental Biotechnology

Course code:	**SC/BT/PG/GE/334T, Animal and Developmental Biotechnology**	**L T P C** **6 0 0 6**
Course Prerequisites	**SC/BT/PG/131T Cell Biology** **SC/BT/PG/133T Fundamentals of Molecular Biology and Microbial Genetics** **SC/BT/PG/231T Advanced Molecular Biology and Genetics** **SC/BT/PG/331T Recombinant DNA Technology**	
Objectives:	The course aims to provide adequate knowledge about • In depth knowledge about isolation and maintenance of animal cells in culture and their application in the production of human and animal viral vaccines, antibodies and pharmaceutical proteins. • Detailed concept on development of an organism starting from Birth, Growth and Death processes. • Thorough understanding of the genetic basis for disease resistance in animals and molecular diagnostics of pathogens in plants and animals • The different aspects of molecular medicine & diagnosis and gene therapy.	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Gather knowledge to maintain cultured cells in vitro for the production of vaccines and recombinant proteins. (K1, K2, K3, A1, A2) **CO2:** Acquire in depth knowledge about several techniques used in Recombinant DNA Technology for therapeutic production of antibodies and antibody mediated drug delivery (K1, K2, K3, A1, A2) **CO3:** Understand the detailed cell and molecular biology of animal development and apply those knowledge for betterment in reproductive biology (K1, K2, K3, K4A1, A2, A4)	
Unit I	**Animal Cell Culture** Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.	
Unit II	**Animal Reproductive Biotechnology** Structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology.	
Unit III	**Developmental Biology** Gametogenesis, fertilization and development: Gamete formation, cell surface molecules in sperm-egg recognition, Zygote, cleavage, morula, blastula, gastrula, 3 germ layers	

	formation and embryogenesis; Morphogenesis and organogenesis: Gamet production and fertilization in Sea urchin; Molecular regulation of development in Drosophila (maternal gene, pair rule gene); Life cycle and certain feature of development in C. elegans, Drosophila; Extraembryonic membrane development in chick.
Unit IV	**Unit IV: Molecular mapping and marker assisted selection** Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.
Unit V	**Vaccinology** History of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.
Unit VI	**Molecular Medicine** Therapeutic production of antibodies, antibody mediated drug delivery. Transgenic animals for the production of therapeutic agents, transgenic animals as disease model. Development of targeted drug delivery, Nucleic acid as therapeutic agents.
Unit VII	**Molecular Diagnosis** Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH), Recombinant DNA Technology in medicine, Polymerase Chain Reaction in clinical diagnostics, DNA sequencing of representative clones to detect mutation(s), PCR-SSCP to detect mutations.
Unit VIII	**Gene therapy** Delivery of therapeutic gene, non viral delivery system, tissue engineering, Ethical problems around prenatal diagnosis.
Text Books	1.Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press. 2.Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub. 3. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub. 4.Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press. 5. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International. 6. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker. 12. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.
Reference Books	1. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.

	2. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub. 3. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
Mode of Evaluation	Written Class Test Final-Written Term End Examination
Course delivery format	Blackboard, Power point presentation and tutorial assignment
Supplementary academic support	guide students to get online materials, providing you tube link, providing review articles on relevant topics etc
Other learning activities	Discussion, consulting problems
Supporting Laboratory course	SC/BT/PG/386L, Molecular Biology and Recombinant Technology Laboratory and SC/BT/PG/ 146 L : **Biophysics, Cell Biology and Genetics Laboratory**
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
SC/BT/PG/331T	CO1	3	3	2		1								3	3	2	
	CO2	3	3	3		1								3	3	2	
	CO3	3	3	2		1								3	3	1	

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/386L: Laboratory IV: Molecular Biology and Recombinant DNA Technology Laboratory

Course code:	**SC/BT/PG/386L, Molecular Biology and Recombinant Technology Laboratory**	**L T P C** **0 2 6 8**
Course Prerequisites	**SC/BT/PG/133T Fundamentals of Molecular Biology and Microbial Genetics** **SC/BT/PG/231T Advanced Molecular Biology and Genetics** **SC/BT/PG/331T Recombinant DNA Technology**	
Course Outcomes:	On completion of the course, the students will be able to CO1: To illustrate creative use of modern tools and techniques for extractions and genome. CO2: To expose students to application of recombinant DNA technology in biotechnological research. CO3: To train students in strategizing research methodologies employing genetic engineering techniques.	
Syllabus :	1. Genomic DNA isolation and Agarose gel electrophoresis 2. Plasmid DNA isolation and DNA quantitation 3. Restriction Enzyme digestion of plasmid DNA 4. Polymerase Chain Reaction and analysis by agarose gel electrophoresis 5. Vector and Insert Ligation 6. Preparation of competent cells 7. Transformation of E. coli with standard plasmids, Calculation of transformation efficiency 8. Confirmation of the insert by Colony PCR and Restriction mapping	
Recommended by the Board of Studies on	February 13, 2020	
Date of Approval by the Academic Council	December 10, 2020	

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
SC/BT/PG/386L	CO1	3	3	3	2	2		1		2		2	3	3	3	3	1
	CO2	3	3	3	2	2		1		2		2	3	3	3	3	1
	CO3	3	3	3	2	2		1		2		2	3	3	3	3	1

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							

SC/BT/PG/385L: Immunology Laboratory

Course code:	**SC/BT/PG/385L, Immunology Laboratory**	**L T P C** **0 2 6 8**
Course Prerequisites	**SC/BT/PG/233T Immunology**	
Objectives:	The course aims to provide adequate knowledge about • To provide hand on experience on antigen antibody interaction.(K1,K2,A1) • To develop skill to use modern immunological techniques used in diverse biotechnological research (K1,K2, K3,A1)	
Course Outcome:	On completion of the course, the students will be able to **CO1:** Use immune cells and antigen antibody interaction in different research areas. **CO2:** Use modern techniques like Elisa, immune-blotting, in both fundamental and translational research.	
Unit I	Double diffusion, Immuno-electrophoresis To identify antigen or antibody using simple techniques, development of idea about zone of equivalence.	
Unit II	SDS-PAGE, Immunoblotting: Preparation of SDS-PAGE and running samples, transfer of samples, and immunoblotting with antibody.	
Unit III	Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation Separation of primary lymphocytes from whole blood and store them for future use.	
Unit IV	Demonstration of ELISPOT Rapid and simple detection of antigen	
Unit V	Demonstration of localization of protein by Indirect immunolabeling Preparation of cultured cells for fixation, incubating with primary and secondary antibody and visualization under fluorescence microscope	
Text Books	1) **Practical Immunology, Fourth Edition** Author(s):Frank C. Hay PhD,, Olwyn M.R. Westwood PhD, 2) **Roitt's Essential Immunology Author Peter J. Martin, Seamus J. Delves.**	
Reference Books	1) 2) 3) 4)	
Mode of Evaluation	Practical exam followed by viva	
Course delivery format	Hand on , each student individually	
Supplementary academic support	Theoretical lecture	
Other learning activities	Online materials	
Supporting Laboratory course		
Recommended by the Board of Studies on	February 13, 2020	
Date of Approval by the Academic Council	December 10, 2020	

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/385L		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
	CO1	3	2	3	3	3								3	2	3
	CO2	3	2	3	3	3								3	2	3

CO1: Use immune cells and antigen antibody interaction in different research areas.
CO2: Use modern techniques like Elisa, immune-blotting, in both fundamental and translational research.

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

Semester - IV

SC/BT/PG/481T: Selected Topics in Biotechnology

Course code and Name:	**SC/BT/PG/481T, Selected Topic in Biotechnology**	**L T P C** **4 4 0 8**
Course Prerequisites	**Knowledge in all subjects taught in last three semester.**	
Objectives:	The course aims to provide adequate knowledge about • Ethical issues, safety, the rights of the intellectual properties, new and emerging techniques of various aspects of Biotechnology such as bioprocess engineering, drug discover, project drafting, vaccine development, tissue engineering etc. (K1, K2,A1) • Newer, industrially important technologies, their history of development, current status, and future challenges (K1,K2, K3, A1)	
Course Outcome:	On completion of the course, the students **CO1:** Will appreciate relevance of Ethical issues, biosafety, and the rights of the intellectual properties, new and emerging techniques of biotechnological industries. **CO2:** will be familiar with the field of microbial technology for use in human welfare and solving problems of the society. **CO2:** Would develop deeper understanding of the industrial Biotechnology, Drug discovery, vaccine development and its applications. **CO4:** understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.	
Unit I	1. Intellectual Property Rights, Biosafety and Bioethics 2. Modeling and Analysis of Bioprocesses Engineering and Technology 3. Cell and Tissue Engineering 4. Molecular Diagnostics and Therapeutics 5. Nanobiotechnology 6. Bioentrepreunership 7. Project Proposal Preparation and Presentation 8. Biological Imaging 9. Protein Engineering 10. Vaccines.	
Text Books	Will be informed by the course providers in each topic.	
Reference Books	Will be informed by the course providers in each topic.	
Mode of Evaluation	Theoretical written exam (MCQ Type), group discussion and presentation.	
Course delivery format	Physical offline or Virtual online lectures, Group Discussion, Seminar presentation, followed by distribution of course materials	
Supplementary academic support	Theoretical lecture and Tutorial Support	

Other learning activities	Online materials
Supporting Laboratory course	
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/481T		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO3 12	PS O1	PS O2	PS O3	PS O3
	CO1	2	2	2	2	2	3	1	3	3	3	1	3	3	3	3	3
	CO2	3	2	3	3	3	3	1	2	3	2	1	3	3	3	3	3
	CO3	3	3	3	3	3	3		2	3	2	1	3	3	3	3	3
	CO4	3	3	3	3	3	3	1	3	3	3	1	3	3	3	3	3

CO1: Will appreciate relevance of Ethical issues, biosafety, and the rights of the intellectual properties, new and emerging techniques of biotechnological industries.
CO2: will be familiar with the field of microbial technology for use in human welfare and solving problems of the society.
CO2: Would develop deeper understanding of the industrial Biotechnology, Drug discovery, vaccine development and its applications.
CO4: Understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/482SEC: Critical Analysis of Research methodology and Scientific Communication Skill

Course code and Name:	**SC/BT/PG/482SEC, Critical Analysis of Research methodology and Scientific Communication Skill**	**L T P C** **4 4 0 8**
Course Prerequisites	**Knowledge in all subjects taught in last three semester.**	
Objectives:	The course aims to let the student • Think critically when study/read the new and emerging papers of scientific discoveries (K1, K2, A1) • Analyze whether the methodologies used to do those research were appropriate and relevant (K1,K2, K3, A1).	
Course Outcome:	On completion of the course, the students **CO1:** will be able to think critically about the scientific papers of scientific discoveries **CO2:** realize how the major and crucial conclusions were deduced. **CO3:** use framework of various methodologies for effective lab practices and scientific communication. **CO4:** appreciate scientific ethics and follow the appropriate code of conduct of science.	
Course Outline	• Each group of 5-6 students will be assigned a mentor, who will assign a few key reference papers. • The students in the group will study the topic, from multiple papers/review articles/papers as needed, deliver a presentation. • The presentation will be evaluated by all the teachers consisting of one/two external examiners) (25 marks). • In addition, the group will also write a review article which consists of a background of the topic, current development in the area, and future perspective describing which way the future research should be directed (25 marks).	
Text Books	Will be informed by the course providers/mentors in each topic	
Reference Books	Will be informed by the course providers/mentors in each topic	
Mode of Evaluation	Group Presentation, group discussion, seminar presentation, and Project and Review Writing.	
Course delivery format	Physical offline or Virtual online lectures, followed by distribution of historically important Scientific Papers of	
Supplementary academic support	Theoretical lecture and Tutorial Support	
Other learning activities	Online materials	
Supporting	Not Applicable	

Laboratory course	
Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/482 SEC		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO3 12	PS O1	PS O2	PS O3	PS O3
	CO1	2	2	2	2	2							3	3	3	3	3
	CO2	3	2	3	3	2							3	3	3	3	3
	CO3	3	3	3	3	2							3	3	3	3	3
	CO4	3	3	3	3	2							3	3	3	3	3

CO1: Will be able to think critically about the scientific papers of scientific discoveries
CO2: Realize how the major and crucial conclusions were deduced.
CO3: Use framework of various methodologies for effective lab practices and scientific communication.
CO4: Appreciate scientific ethics and follow the appropriate code of conduct of science.

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/483SEC: Student's Project Work and Dissertation

Course code and Name:	**SC/BT/PG/482SEC, Student's Project Work and Dissertation**	**L T P C** **0 0 8 8**
Course Prerequisites	**Knowledge in all subjects taught in last three semester.**	
Objectives:	The course aims to let the student • Think critically when study/read the new and emerging papers of scientific discoveries (K1, K2, A1) • Analyze whether the methodologies used to do those research were appropriate and relevant (K1, K2, K3, A1).	
Course Outcome:	On completion of the course, the students **CO1:** will be able to design new scientific experiments leading to scientific research **CO2:** learn various new methods and techniques. **CO3:** learn how to present the report of his/her research findings in a scholarly manner in the form of a dissertation. **CO4:** learn how to present his/her research in platform presentations.	
Course Outline	• Each student will be assigned to a scientist/faculty member belonging to a different Research Institute/University to carry out a small research project in his/her laboratory. • Each student will be working on a separate problem for 12 weeks/3 months, which would be designed by the external supervisor. At the end of the tenure each student would write a dissertation/thesis on the work they carried out describing in detail the background, materials & methods, results, discussion, future work, and reference as well • Each student will present his/her work in front of panel of examiners consisting of the internal and external examiners. They will be evaluated on the basis of their dissertation (25 marks) and presentation (25 marks).	
Text Books	Will be informed by the course providers/mentors in each topic	
Reference Books	Will be informed by the course providers/mentors in each topic	
Mode of Evaluation	Supervisor's Feedback, Project Report, Group and individual Presentation.	
Course delivery format	Not Applicable	
Supplementary academic support	Not Applicable	
Other learning activities	Not Applicable	
Supporting Laboratory course	Not Applicable	

Recommended by the Board of Studies on	February 13, 2020
Date of Approval by the Academic Council	December 10, 2020

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/482SEC		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO3 12	PS O1	PS O2	PS O3	PS O3
	CO1	2	2	2	2	2							3	3	3	3	3
	CO2	3	2	3	3	2							3	3	3	3	3
	CO3	3	3	3	3	2							3	3	3	3	3
	CO4	3	3	3	3	2							3	3	3	3	3

CO1: Will be able to think critically about the scientific papers of scientific discoveries
CO2: Realize how the major and crucial conclusions were deduced.
CO3: Use framework of various methodologies for effective lab practices and scientific communication.
CO4: Appreciate scientific ethics and follow the appropriate code of conduct of science.

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

SC/BT/PG/484SEC: Grand Viva

Course code and Name:	**SC/BT/PG/482SEC, Grand Viva**	**L T P C** **0 8 0 8**
Course Prerequisites	**Knowledge in all subjects taught in last three semesters.**	
Objectives:	The course aims to let the student • Think critically and answer questions promptly and correctly (K1, K2, A1). • Assess the strength and weakness in different subjects (K1, K2, K3, A1). • Prepare them for encountering professional interviews of different institutions and companies.	
Course Outcome:	On completion of the course, the students **CO1:** Demonstrate knowledge, analytical and quantitative skill in the diverse domains of Biotechnology. **CO2***:* Exhibit one's ideas, views, and intuition in designing scientific research cogently and precisely. **CO3**: Display technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology **CO4:** Recognize the knowledge and skills in the industrial and professional Bioethics, IPR, entrepreneurship, Communication and management skills so as to prepare next generation of researchers.	
Course Outline	A grand viva examination will be conducted at the end of semester IV which include all the topics taught in all the courses and subjects from semester I to semester IV. Each students will be interrogated separately from diverse topics of biotechnology to test and assess the overall knowledge, analytical ability, mental agility of the students. The major objective of this course is to test overall knowledge a students gathered during the entire tenure of the M. Sc. in Biotechnology Course at JU and also to prepare the students for the job and Ph. D. interviews for their future job search.	
Text Books	Not Applicable	
Reference Books	Not Applicable	
Mode of Evaluation	Independent Closed Door Interrogation.	
Course delivery format	Not Applicable	
Supplementary academic support	Not Applicable	
Other learning activities	Not Applicable	
Supporting Laboratory course	Not Applicable	
Recommended by the Board of Studies on	February 13, 2020	
Date of Approval	December 10, 2020	

by the Academic Council	

CO-PO Mapping :(3 – Strong, 2 – Moderate and 1 – Weak)

SC/BT/PG/482SEC		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO3 12	PS O1	PS O2	PS O3	PS O3
	CO1	2	2	2	2	2							3	3	3	3	3
	CO2	3	2	3	3	2							3	3	3	3	3
	CO3	3	3	3	3	2							3	3	3	3	3
	CO4	3	3	3	3	2							3	3	3	3	3

CO1: Demonstrate knowledge, analytical and quantitative skill in the diverse domains of Biotechnology.
CO2*:* Exhibit one's ideas, views, and intuition in designing scientific research cogently and precisely.
CO3: Display technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology
CO4: Recognize the knowledge and skills in the industrial and professional Bioethics, IPR, entrepreneurship, Communication and management skills so as to prepare next generation of researchers.

CO-AT Matrix

CO-AT Matrix	CT1	CT2	CEF	SEE		Cut off(%)	Target(%)
CO1							
CO2							
CO3							
CO4							

EXAMINATION RULES FOR DEGREE OF MASTER OF SCIENCE COMMON FOR ALL M.SC COURSES (SEMESTER SYSTEM) OF JU UNDER THE FACULTY OF SCIENCE

1. All M.Sc (day) courses will be of two-year four-semester course and all M.Sc (evening) courses will be of three-year four-semester course.- First Semester, Second Semester, Third Semester and Fourth Semester under the Faculty of Science.

2a) **For Day course** -: The Examination shall be held at the end of each semester

2b) Students must pass (a minimum of 40%) separately in every paper of all the four semesters examinations and those who pass in a paper shall not be permitted to sit for the examination in that paper again. Non-appearance in a paper/examination will be count as failure in that paper/ examination and count towards a chance.

3. No student shall be permitted to sit for the M.Sc. examination after the lapse of FIVE ACADEMIC SESSIONS (day) from the SESSION of ADMISSION to the M.Sc. first semester class.

4. Each student will have to pass every paper **separately** in each semester of the programme of study. If a student fails to pass or appear in one or more papers in the first semester and second semester examinations, he/she may appear in that-those paper(s) at the regular semester examination along with the regular students in the next academic session.

A Special Supplementary examination for the third semester and fourth semester (taking both the semester together) will be held normally after 30 days from the publication of fourth semester results. Students, who do not have any back papers in any of the previous 1st & 2nd semesters, shall be only eligible to appear at the supplementary examination. Students who fail to submit their dissertation, seminars and comprehensive viva will not come under the purview of the supplementary examination.

5. A student will appear in all the papers meant for/taken at the regular semester examinations (first semester, second semester, third semester and fourth semester) to be held after the conclusion of the respective semester programme of studies and as per the date announced by the Controller of Examinations on the basis of the Academic calendar, fixed by the Faculty Council for the P.G. & U.G. Studies in Science.

1. A student will carry on with the subsequent semester programme of studies irrespective of the result of the previous semester examination.

7. Student must complete the seminar and submit dissertation/ project before commencement of the fourth semester examination. The grand viva-voce(whenever applicable) will be held after the completion of examination on theoretical and practical papers of the fourth semester examination.

8. Eligibility of a student to sit for any semester examination will be further guided by the existing 'attendance rule' of the Faculty of Science.

9. The dissertation/project will be adjudicated by a panel of examiners, including one external examiner (out side of Jadavpur University) to be appointed by Controller of Examinations in consultation with the Head of the Department.

10. A Viva-voce will be conducted by those examiners who have adjudicated the dissertation/ project. Viva-voce will be a defense of the dissertation/project and it will be treated as a part of the examination. Non-appearance in viva-voce, however, will be count as failure for which candidate will be required to appear at the Special Supplementary Examination provided however provision as laid down in (7) above is applicable to him/her.

11. If a student fails to submit his/her dissertation/project within the stipulated date, he/she may submit the same prior to holding of the fourth semester Special Supplementary Examination. The date of submission will be announced by the Controller of Examinations in consultation with Head of the Department.

12. Student for availing of the number of chance/chances may be required to enroll their names as casual student. Such casual enrolment is required for those who will not be able to clear their back papers/grand viva/seminar/dissertation/project within the regular tenure.

13. For the grand viva (wherever applicable), teachers of the department will be the examiner along with one external examiner (out side Jadavpur University) to be appointed by Controller of Examinations in consultation with the Head of the Department.

14. Pass mark will be 40% in each paper both in theoretical and in practical examination, and /grand viva/seminar/dissertation/project. Candidate securing 60% or more of the aggregate marks in the total number of papers in all the semesters including /grand viva/seminar/dissertation/project will be declared to have passed in First Class and other successful candidates securing 40% and above but below 60% of the aggregate marks in the total number of papers in all the semesters including /grand viva/seminar/dissertation/project will be declared to have passed in Second Class.

15. A student who has passed in all the semester papers in the regular semester examination and submitted his/her project/dissertation/grand viva within the schedule date shall be placed in their appropriate class and shall hold such position in their respective class list in order of merit as the percentage of marks secured by them may warrant.

16. A student who had appeared in any examination along with the student of the next academic session and / or appeared at the Supplementary Examination and/or submitted/completed his/her project/dissertation/grand viva not at the first chance will be placed in appropriate class in order of merit but shall be placed below the list of the candidates as determined under the clause above irrespective of the fact that he/she might have secured higher aggregate of marks that the candidate whose merit list has been determined according to the same provision.

17. Grafting of a maximum 5 marks among the final semester theoretical papers only may be allowed to the final semester students who have passed all the papers of previous semester examinations. No grafting shall be made from practical papers/project/dissertation/grand viva etc.

18. All the theoretical papers will be evaluated by the internal examiners. Practical/dissertation/ project/grand viva etc. will be evaluated by both internal and external examiners.

19. The result will be declared in grade system for each semester. In the final semester grade card, there will be a provision for indicating both total marks (theoretical and practical) and class obtained.

20. All the other regulations/rules which are not mentioned above (1 to 19) shall be under the existing regulations/rules of the University.

CLASSIFICATION OF GRADES

GRADE	MARKS (Theoretical/Practical)
A	75% and above
B	65% to below 75%
C	50% to below 65%
D	40% to below 50%
X	Below 40% (Failed)