MANIPAL SCHOOL OF LIFE SCIENCES
MANIPAL
(A constituent unit of MAHE, Manipal)

MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

Manipal School of Life Sciences

Manipal Academy of Higher Education, Manipal

Outcomes Based Education (OBE) Framework

Four Year Full Time Undergraduate Program

B.Sc. Biotechnology (Honours)

2023

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1. NATURE AND EXTENT OF THE PROGRAM

B.Sc. Biotechnology (Honours) Degree Program:
B.Sc. Biotechnology (Honours) is an undergraduate program covering the broad aspects of various areas of biotechnology to help choose a career in Life Sciences research and development. The main focus of the program is to gain basic knowledge in biotechnology through lectures and hands-on training, culminating in an extended research project work.

Duration of the Program:
The duration of the study of the B.Sc. (Honours) degree shall extend over a total period of four academic years divided into eight semesters of 6 months (4 odd semesters and 4 even semesters) each from the date of commencement of study for courses comprising the curriculum. The student has to carry out project work in the last three semesters of the program (18 months).

Medium: The medium of instruction and examination in the program shall be in English.

Eligibility:
Qualification: Pass in 10+2, A-Level, IB, American 12 grade or equivalent with English, Biology, Chemistry, and Physics or Biotechnology or Mathematics or any other Life Sciences subjects as optional subject and a minimum of 55% marks taken together in Biology, Chemistry, and Physics or Biotechnology or Mathematics or any other Life Sciences subject.

Candidates who have successfully completed six semesters of B.Sc. Biotechnology program with CGPA 7 and above are eligible to continue for 7^{th} and 8^{th} semesters of B.Sc. Biotechnology (Honours) program.

Courses covered include different areas of biotechnology, including genetics, molecular biology, cell biology, bioinformatics, biophysics, and business studies. Training on contemporary courses with state-of-the-art facilities.

Meritorious graduates gain postgraduate admissions in various fields in life sciences, health sciences, business administration, bioinformatics, systems biology and such, in India and abroad. A Postgraduate degree helps in better career prospects.

2. PROGRAM EDUCATION OBJECTIVE (PEO)

The overall objectives of the Learning Outcomes-based Curriculum Framework (LOCF) for **B.Sc. Biotechnology (Honours) program** are as follows.

PEO No	Education Objective
PEO 1	Students will be able to use their fundamental concepts and technical competence in Biotechnology as and when required to achieve professional excellence.
PEO 2	Students will demonstrate strong and well defined practical knowledge in different areas of Biotechnology, including genetics, molecular biology, cell biology, bioinformatics, biophysics, and business studies.
PEO 3	Students will be able to practice the profession with a highly professional and ethical attitude, strong communication skills, and effective professional skills to work in a team with multidisciplinary approval.
PEO 4	Students will be able to use interpersonal and collaborative skills to identify, assess, and formulate problems and execute the solution in closely related issues in the Biotechnology domain.
PEO 5	Students will be able to imbibe the culture of research, innovation, entrepreneurship, and incubation.
PEO 6	Students will be able to participate in a lifelong learning process for a highly productive career and will be able to relate the concepts of Biotechnology towards serving the cause of the society.

3. GRADUATE ATTRIBUTES:

S No.	Attribute	Description
1	**Disciplinary Knowledge**	Knowledge of Biotechnology theories. Acquiring knowledge of different dimensions of the Biotechnology domain, learning various techniques of biotechnology and other related areas of studies such as bioinformatics, biophysics, and business studies.
2	**Understanding different subsets of Biotechnology**	Different areas of Biotechnology including genetics, molecular biology, cell biology, biochemistry, bioinformatics, biophysics, and business studies.
3	**Measurable Skills and Industry-ready Professionals**	Strengthening the abilities of a learner by skills, gaining knowledge of the present scenario of the Biotechnology industry and training.
4	**Effective and Influencing communication**	Effective and Influencing communication ability to share thoughts, ideas and applied skills of communication in its various perspectives like written communication, speech communication etc.
5	**Leadership readiness/ Qualities**	To make learners fluent in multiple facets of leadership. Creating the ability & enhancing the qualities to be an efficient leader. Cultivating key characteristics in learners, to be visionary leaders who can inspire the team to greatness.
6	**Critical/ Reflective thinking & language efficiency**	Critical/ Reflective thinking ability to employ critical and reflective thinking along with the ability to create the sense of awareness of one self and society.
7	**Technologically Efficient Professional**	Capability to use various biotechnology techniques and tools.
8	**Ethical Awareness**	As a biotechnologist, one has to understand the importance of ethical values and its application in professional life.
9	**Lifelong Learning**	Every graduate to be converted into lifelong learner and consistently update himself or herself with current knowledge, skills and technologies. Acquiring Knowledge and creating the understanding in learners that learning will continue throughout life.
10	**Research-related Skills**	A sense of inquiry and investigation for raising relevant and contemporary questions, synthesizing and articulating.
11	**Cooperation/ Team work**	Building a team, motivating and inspiring the team members to work up with cooperation to their utmost efficiency.

4. QUALIFICATIONS DESCRIPTORS

1. Demonstrate
   (i) a systematic, extensive and coherent knowledge and understanding of an academic field of study as a whole and its applications, and links to related disciplinary areas/courses of study; including a critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues in the field of Biotechnology;
   (ii) Procedural knowledge that creates different types of professionals related to the Biotechnology industry, including research and development, teaching and government and public service;
   (iii) Professional and communication skills in the domain of Biotechnology

2. Demonstrate comprehensive knowledge about materials, including current research, scholarly, and/or professional literature, relating to essential and advanced learning areas pertaining to the Biotechnology field of study, and techniques and skills required for identifying problems and issues related.

3. Demonstrate skills in identifying information needs, collection of relevant quantitative and/or qualitative data drawing on a wide range of sources, analysis and interpretation of data using

4. Methodologies as appropriate to the course(s) for formulating evidence based solutions and arguments

5. Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.

6. Communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts and techniques of the Biotechnology studies

7. Address one's own learning needs relating to current and emerging areas of study, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge.

8. Apply one's disciplinary knowledge and transferable skills to new/unfamiliar contexts and to identify and analyse problems and issues and seek solutions to real-life problems.

5. <u>PROGRAM OUTCOMES</u>: After successful completion of B.Sc. Biotechnology (Honours) program, students will have:

PO No	Attribute	Competency
PO 1	**Disciplinary knowledge**	Capability of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate program of study.
PO 2	**Communication Skills**	Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
PO 3	**Critical thinking**	Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.
PO 4	**Problem solving**	Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.
PO 5	**Analytical reasoning**	Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
PO 6	**Research-related skills**	A sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.
PO 7	**Cooperation/Team work**	Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.
PO 8	**Scientific reasoning**	Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
PO 9	**Reflective thinking:**	Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
PO 10	**Information/digital literacy**	Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
PO 11	**Self-directed learning**	Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
PO 12	**Multicultural competence**	Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

PO 13	**Moral and ethical awareness/reasoning**	Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting an objective, unbiased and truthful actions in all aspects of work.
PO 14	**Leadership readiness/qualities**	Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
PO 15	**Lifelong learning**	Ability to acquire knowledge and skills, including „learning how to learn," that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of the workplace through knowledge/skill development/reskilling.

6. COURSE STRUCTURE, COURSEWISE LEARNING OBJECTIVE, AND COURSE OUTCOMES (COs)

FIRST YEAR:

Semester: 1 **Semester: 2**

Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
BBT 101	Basics of Biotechnology	3	-	-	3	BBT 102	Cell Biology	3	-	-	3
BBT 103	Biology-I	3	-	-	3	BBT 104	Biochemistry	3	-	-	3
BBT 105	Biology-II	3	-	-	3	BBT 106	Environmental Science	3	-	-	3
BBT 107	Chemistry	3	-	-	3	BBT 108 (or) BBT 110	Physics (or) Advanced Chemistry	3	-	-	3
BBT 109	Computer Science	3	-	-	3	BBT 112	Cell Biology	-	-	4	2
BBT 111	Biology-I	-	-	2	1	BBT 114	Biochemistry	-	-	4	2
BBT 113	Biology-II	-	-	2	1	BBT 116	Environmental Science	-	-	4	2
BBT 115	Chemistry	-	-	2	1	BBT 118 (or) BBT 120	Physics (or) Advanced Chemistry	-	-	2	1
BBT 117	Computer Science	-	-	2	1	BBT 122	Seminar/Journal Club	-	1	-	1
BBT 119	Seminar/Journal Club	-	1	-	1						
	Total	**15**	**1**	**8**	**20**		**Total**	**12**	**1**	**14**	**20**
*- includes 1h/week/course for field visits and other related activities, as applicable											

SECOND YEAR:

Semester: 3 **Semester: 4**

Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
BBT 201	Genetics	3	-	-	3	BBT 202	Biostatistics	3	-	-	3
BBT 203	Molecular Biology	3	-	-	3	BBT 204	Pharmacology & Pharmacogenomics	3	-	-	3
BBT 205	Microbiology	3	-	-	3	BBT 206	Plant Biotechnology	3	-	-	3
BBT 207	Biophysics	3	-	-	3	BBT 208	Bioinformatics	3	-	-	3
BBT 209	Genetics	-	-	4	2	BBT 210 (or) BBT 212	Immunology (or) Cell & Tissue Engineering	3	-	-	3
BBT 211	Molecular Biology	-	-	4	2	BBT 214	Pharmacology & Pharmacogenomics	-	-	2	1
BBT 213	Microbiology	-	-	4	2	BBT 216	Plant Biotechnology	-	-	2	1
BBT 215	Biophysics	-	-	2	1	BBT 218	Bioinformatics	-	-	2	1
BBT 217	Seminar/Journal Club	-	1	-	1	BBT 220 (or) BBT 222	Immunology (or) Cell & Tissue Engineering	-	-	2	1
						BBT 224	Seminar/Journal Club	-	1	-	1
	Total	**12**	**1**	**14**	**20**		**Total**	**15**	**1**	**8**	**20**

THIRD YEAR:

Semester: 5 **Semester: 6**

Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
BBT 301	Microbial Biotechnology	3	-	-	3	BBT 302	Tutorial/Seminars/ Journal Club	-	4	-	4
BBT 303	Developmental Biology	3	-	-	3						
BBT 305	Advanced Genomics	3	-	-	3						
BBT 307	Nanobiotechnology	3	-	-	3	BBT 399	Research Project/ Submission of dissertation/ Submission of manuscript	-	-	32	16
BBT 309	Research Methodology	3	-	-	3						
BBT 311	Microbial Biotechnology	-	-	2	1						
BBT 313	Developmental Biology	-	-	2	1						
BBT 315	Advanced Genomics	-	-	2	1						
BBT 317	Nanobiotechnology	-	-	2	1						
BBT 319	Seminar/Journal Club	-	1	-	1						
	Total	**15**	**1**	**8**	**20**		**Total**	**-**	**4**	**32**	**20**

FOURTH YEAR

Semester: 7 **Semester: 8**

Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
BBT 401	Laboratory Rotation	-	-	8	4	BBT 402	Tutorials/Seminars /Journal Club	-	8	-	4
BBT 403	Tutorials/Seminars/Journal Club		4	-	4						
BBT 405	Research Project work progress report I submission/presentation	-	-	24	12	BBT 499	Research Project work /Submission of manuscript	-	-	32	16
	Total	**-**	**4**	**32**	**20**		**Total**	**-**	**4**	**32**	**20**

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Basics of Biotechnology (Theory)**
Course Code: BBT 101	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: I Year, I Semester**
No of Credits: 3	**Prerequisites: Admission to B.Sc. program**
Synopsis:	The objective of this course is to acquaint the students with the fundamentals of biotechnology and its impact on the living system and environment. Further, to understand the role of modern technology, bioethics, good practices and biosafety, and its impact on society with improved productivity.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Define the various components of biotechnology, discuss the scope and application and explain the concept of biotechnology for society (C1, C2, C3)
CO 2:	Explain the importance of biotechnological tools and its impact on agricultural productivity and environment (C2, C3, C4)

CO 3:	Demonstrate the use of modern tools/technology on bioprocessing, food technology, and nanobiotechnology; for human, plant and animal health (C2, C3, C4)
CO 4:	Outline the importance of IPR, safety aspects, commercial potential of GMOs and public acceptance (C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×				×										
CO 4	×		×												

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction to Biotechnology	• Define various components of biotechnology and their importance (C1, C2, C3) • Illustrate recent advances in biotechnology and molecular biology (C2, C3) • Demonstrate various recombinant DNA and genome sequencing techniques (C2, C3)	4
Unit 2:		
Biotechnology and Plants	• Interpret the focus area of agricultural biotechnology (plants and animals) and forest biotechnology (C1, C3) • Compare the different techniques and its impact on agricultural and forest productivity (C3, C4)	6
Unit 3:		
Biotechnology and environment	• Outline the major source of marine organisms for food production, major factors of different ecosystem and its maintenance through biotechnological tools. (C1, C2, C3)	6
Unit 4:		
Biotechnology and health	• Infer the potential role of modern technology for the production of recombinant medicine (hormones, vaccines and other proteins) (C2, C4) • Apply the imperative role of molecular biology methods for forensic science (C3)	6
Unit 5:		
Bioprocessing	• Explain the role of fermentation biotechnology for large scale production of metabolites/enzymes for commercial application (C2, C5)	4
Unit 6:		
Biotechnology for future	• Outline the emerging role of nanotechnology on food technology and the safety (C2)	6
Unit 7:		
Intellectual Property Rights	• Explain the regulations of intellectual property rights in biotechnology and its application (C2, C3) • Illustrate the rules and regulation for patent filing and further processing (C2) • Explain the biosafety and management of biotechnological products (food, medicine and industry) (C2, C3)	3
Unit 8:		

Safety aspects in biotechnology	• Demonstrate the protocol for GLP, GMP and containment system for GMOs (microbes, plants and animals) (C2)	6
Unit 9:		
Biotechnology and Society	• Explain the safety aspects of GMOs, advantages and disadvantages (C2, C3) • Give an outline on commercially available GMOs in India and their impact on agricultural growth (C2)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

c

Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination	x	x		
Quiz				
Assignment/Presentation	x	x	x	x
End Semester Examination	x	x	x	x
Laboratory examination	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	1. Bioprocess Engineering – Basic Concepts (2nd ed.) - 2001 – Shuler ML, Kargi F - Prentice Hall. 2. Introduction to Plant Biotechnology (2nd ed.) – 2002 – Chawla HS - Science Publishers Inc. 3. Molecular Biology and Biotechnology (4th ed.) - 2001, - Walker JM, Rapley R - Royal Society of Chemistry. 4. Biotechnology (2nd ed.) - 2001 - Rehm HJ - VCH (University of Michigan). 5. Biotechnology from A to Z, (2nd ed.) - 1998 – Bains W - Oxford University Press. 6. Elements of biotechnology- P. K. Gupta, Rastogi publications.\ 7. Biotechnology-Expanding Horizons-B.D. Singh, 2004 (revised and reprinted, 2019); Kalyani Publishers, New Delhi. 8. Plant Biotechnology. B.D. Singh, 2015 (revised and reprinted, 2019); Kalyani Publishers, New Delhi. 9. Genetics, B.D. Singh, 2002 (revised and reprinted, 2020); Kalyani Publishers, New Delhi.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biology-I (Theory)**
Course Code: BBT 103	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 3	**Prerequisites: Admission to B.Sc. program**
Synopsis:	The objectives of this course are to acquaint the students with animal classification and taxonomic aspects of Animal kingdom. To provide fundamental knowledge on the characteristics of different animal groups, and appreciate the variability in relation to their morphology, anatomy, behaviour and adaptations of different animal groups.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Learn the basis of animal taxonomy, classification, and binominal nomenclature (C1, C2)
CO 2:	Learn the general characteristics of protozoa, *Paramecium* reproduction (C1, C2)
CO 3:	Understand the process of animal body evolution (C1, C2)
CO 4:	Know the major Non-chordate phylum and able to distinguish unique characters (C1, C2)
CO 5:	Know the major Chordate phylum and able to distinguish unique characters (C1, C2)
CO 6:	Know the morphology/internal structures/life cycle of representative specimen from each animal phyla (C1, C2).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×		×		×										
CO 2	×														
CO 3	×				×										
CO 4	×														
CO 5	×		×												
CO 6	×														

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Animal classification	• Understand the history, principles, binomial nomenclature, biological species concept (C1, C2)	4
Unit 2:		
Animal body plan evolution	• Describe the germ layers, symmetry, coelom, protostomes, and deuterostomes (C1, C2)	3
Unit 3:		
Protozoa	• Understand and describe the general characteristics, Paramecium reproduction (C1, C2)	2
Unit 4:		
Non-chordates - I	Understand and describe the general characteristics and classification • Porifera: water canal systems in sponges • Cnidaria: Obelia structure and metagenesis in Obelia Platyhelminthes: Fasciola hepatica life history and its parasitic adaptations • Nematoda: Ascaris life history (C1, C2)	12
Unit 5:		
Non-chordates-II	Understand and describe the general characteristics and classification	9

	• Annelida: Metamerism in Annelida • Arthropoda: Vision in Arthropoda • Mollusca: Torsion in gastropods, Lamellidens internal anatomy • Echinodermata: water vascular system in starfish (C1, C2)	
Unit 6:		
Chordates-I	Understand and describe the general characteristics and classification • Amphibia: Modes of respiration in frog, parental care • Fishes: Osmoregulation in fishes, scale types and migration in fishes • Reptilia: Amniotic egg, identification of common poisonous snakes, poison apparatus and mechanism of biting, Jacobson's, and pit organs (C1, C2)	8
Unit 7:		
Chordates-II	Understand and describe the general characteristics and classification • Aves: flight adaptations, flightless birds • Mammalia: dentition in mammals, adaptive radiation (C1, C2)	7

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	x	x			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	X	x	x	x	x	x
End Semester Examination	X	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Kardong Kenneth, Vertebrates: Comparative Anatomy, Function, Evolution, Boston, Massachusetts, McGraw-Hill, 1998.

	• Kotpal R.L, Modern Textbook of Zoology Invertebrate, Rastogi Publications, 2014. • Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. The Invertebrates: A New Synthesis, III Edition, Blackwell Science, 2002 • Young, J. Z. The Life of Vertebrates. III Edition. Oxford university press. 2004. • Kotpal R.L, Modern Textbook of Zoology Vertebrates, Rastogi Publications, 2004. • Reece, Jane B., and Neil A. Campbell. *Campbell Biology*. Boston: Benjamin Cummings / Pearson, 2011. • Barton Nicholas H et al., Evolution, Cold Spring Harbor Laboratory Press, 2007.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biology-II (Theory)**
Course Code: BBT 105	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 3	**Prerequisites: Admission to B.Sc. program**
Synopsis:	1. This module helps to understand the knowledge obtained in basic courses of Botany. 2. To provide fundamental knowledge of plant morphology, taxonomy, anatomy, physiology & biochemistry and pathology. 3. To understand the fundamental forms of flora and their diversity.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Outline the methods for plant identification using morphological traits
CO 2:	Demonstration of various methods to understand the physiological adaptations collection, preservation and conservation of plant species.
CO 3:	Learning methods to understand the biochemical and physiological complexity
CO 4:	Explain the fundamentals of plant anatomy, reproductive biology and crop improvement strategies,
CO 5:	Discuss and illustrate the plant metabolite identification and product scale up strategies and the role of defence mechanism and pathogenesis in plants and devise strategies to identify, confirm and combat plant pathogens
CO 6:	Discuss the nature of explants and the proliferation capacities for different plant species and impact of various growth regulators (both endogenous and exogenous) along with organogenetic and somatic embryogenic potentials

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	×													
CO 2	×	×													
CO 3	×	×													
CO 4	×	×		×											
CO 5	×	×													
CO 6	×	×								×					

Course content and outcomes:		
Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction and concepts in Botany	• Define and explain fundamental principles of plant biology –Parts of plants (C1, C2) • Understanding the types of plants and its evolution (C2,C4) • Understanding the types of classification (C2, C4)	4

	• Define and explain the significant floral taxa, their life cycles, habit and habitat (C1, C2) • Understanding the evolution of floral life forms and their adaptations (C2, C4)	
`Unit 2:		
Morphology & reproductive cycles	• Provide an outline of the morphological diversity of flora (C2) • Explain the micro and megasporogenesis (C2, C5) • Illustrate the types of embryo in higher plants (C2) • Explain the plant anatomical features and identification of the same (C2, C5) • Identification of architectural variations in different plant parts (C2, C5)	4
Unit 3:		
Fundamentals of Plant Physiology	• Define the fundamentals of plant water relations (C1, C2, C5) • Explain the process of Water absorption (C2, C5, C6) • Demonstrate transpiration and Guttation in plants (C2) • Outline the mechanism of water and solute transport (C2)	4
Unit 4:		
Photosynthesis	• List Photosynthetic events in plants (C1) • Discuss light reactions and mechanism of Electron transport (C6) • Explain different Photosynthetic plant types (C2, C5) • Illustrate and distinguish qualitative and quantitative photosynthetic efficiency (C2) • Explain the fundamentals of Carbon oxidation- Photorespiration (C6) • Understanding the factors influencing photosynthesis and law of limiting factors (C6)	7
Unit 5:		
Plant Respiration	• Define Respiration and the types involved (C1,C2) • Illustrate the primary glycolytic metabolism in plants (C2) • Demonstrate Oxidative phosphorylation (C2) • Explain the process and importance of Kreb's Cycle (C2,C5) • Demonstrate the synthesis of ATP and Energy Utilization and dissipation (C2) • Explain the role of mitochondrial functions during respiratory processes (C2,C5)	7
Unit 6:		
Plant growth	• Define nastic movements in plants (C1) • Explain the phases of growth in plants. (C2,C5) • Illustrate the process of internal and external growth factor regulations (C2) • Explain the functions of plant growth regulators (C2,C5) • Define growth regulators and Cascades involved (C1, C2, C5)	4
Unit 7:		
Plant Pathology	• Illustrate the epidemiology of plant diseases (C2) • Explain the mechanism of defences and types in plants (C2,C5) • Explain the classification and mode of infection of Viral bacterial, fungal and nematode plant pathogens (C2,C5) • Explain the symptoms, Identification, and control measures for above-mentioned pathogens (C2,C5)	6
Unit 8:		

Defence mechanism in plants	• Define the defence mechanism (C1) • Explain the types of defences (C2,C5) • Illustrate the mechanism of operation (C2) • Explain the potential applications of the same in combating pathogens (C2,C5) • Discuss the metabolite armoury in plants (C1, C2, C5)	5
Unit 9:		
Secondary metabolites in plants	• Illustrate the metabolite networks in plants (C2) • Explain the classification and pathways of metabolites (C2,C5) • Explain the relevant ones and their functional roles in plants (C2,C5) • Explain the medicinal and phytochemical efficacy of plant metabolites (C2,C5)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	x	x	x		
Quiz		x		x		x
Assignment/Presentation	X		x			
End Semester Examination	X	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback

Reference Material	• A Stock Book of Biology Vol. I - 2002 - M Sudhakar Rao, - Geetha Publishers, Mysore. • Biological Science (3rd Ed.) - 2002 - Taylor DJ, Green NPO, Stout GW - Cambridge University Press. • Biological Science (3rdEd) - Taylor DJ, Green NPO, Stout GW. - 2002 - Cambridge University Press. • Biology –2002- Chakroborty DP, National Council of Educational Research & Training, India. • Fundamentals of Plant Physiology - 1977 - Jain VK, - S Chand Publishers, New Delhi. • Introduction to principles of Plant Taxonomy – 1991 – VV Sivarajan, • Plant Physiology – 1992 - Salisbury FB, Ross CW - Wadsworth Publishers, UK. • Plant Physiology (5th Ed.) – 2010 - Taiz L, Zeiger E. - Sinauer Associates.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Chemistry (Theory)**
Course Code: BBT 107	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 3	**Prerequisites: Admission to B.Sc. program**
Synopsis:	The objectives of this course are to acquaint the students with general chemistry principles. This course introduces with the following areas in chemistry: inorganic, organic and physical.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Define acid and bases based on various concepts and its limitations, identify conjugate acid-base pairs, Applications of HSAB concept (C1, C2, C3)
CO 2:	Understand the role of metals in biology. Describe physicochemical properties, chemical reactions of oil and determine the physicochemical properties (C1, C2)
CO 3:	Understand thermodynamic terminology and explain fundamental thermodynamic properties. Describe the rate, order of reaction, expression for rate constant, determination of order of reaction and Arrhenius equation (C1, C2, C3)
CO 4:	Applications of solubility product, Calculate the concentration of hydronium ions in the salt solution (salt of weak acid and weak base) (C1, C2, C3)
CO 5:	Understand the Green Chemistry and QSAR with some applications in biotechnology (C1, C2)
CO 6:	Recognise enantiomers, diastereomers or meso compounds, discuss the resolution of racemic mixtures (C1, C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×														
CO 4	×			×											
CO 5	×			×											
CO 6	×														

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Acids and Bases	• Define acids and bases based on various concepts(Arrhenius, Lux Flood, Lewis, lipids and elaborate on its composition and function (C1, C2, C3) • Explain the concept of conjugate acid base pair (C1, C2)	6

	• Summarise the Pearsons HSAB concept and its applications (C1)	
Unit 2:		
Bioinorganic Chemistry	• What is the physiological significance of cooperative binding of oxygen by haemoglobin? (C1) • Outline the fixation of atmospheric nitrogen to form ammonia (C1, C2) • List the metalloenzymes and its biological importance (C1) • Name the bioactive substances containing metals (C1)	3
Unit 3:		
Thermodynamics	• Define heat capacity and terms associated with thermodynamics (C1) • Define first & second law of thermodynamics (C1, C2) • Discuss Joule Thomson effect and its application (C1, C2, C3) • Explain the concept of entropy and its significance (C1, C2, C3) • Explain the significance of Gibbs free energy and relationship with Helmholtz free energy (C1, C2, C3)	5
Unit 4:		
Ionic Equilibria	• Discuss Henderson's equation and preparation of buffer solution(C1, C2) • Discuss the hydrolysis of salt and outline the expression for the pH of hydrolysed salt solution (C1, C2, C3)	6
Unit 5:		
Chemical Kinetics	• Define law of mass action, rate of reaction, order and molecularity of reaction(C1, C2) • Define half-life of the reaction(C1, C2) • Find the order of the reaction by various methods (C1, C2, C3) • Explain the effect of temperature on reaction rate (C1, C2, C3)	7
Unit 6:		
Oils, Fats & Waxes	• Define acid value, saponification value, iodine value, Polenske value, Reichert-Meissl value, acetyl value (C1, C2)	3
Unit 7:		
QSAR	• What is structure activity relationships (SAR) and quantitative structure activity relationships (QSAR) (C1) • List QSAR parameters – Physiochemical parameters lipophilicity –Electronic parameters, Steric parameters(C1) • Show the effect of electronic and steric parameters on lipophilicity (C2)	3
Unit 8:		
Stereochemistry of organic compounds	• Define Optical isomerism-elements of symmetry, chirality, enantiomers, optical activity enantiomers, Diastereomers threo and erythro meso compounds (C1) • List the properties of enantiomers (C1) • Label molecules as enantiomers, diastereomers or meso compounds (C1) • What is resolution of enantiomers? Discuss any three methods. (C1 & C6) • Explain different nomenclature systems of stereoisomers (relative and absolute configuration, sequence rules, D&L, R&S) (C2) • What is Geometrical isomerism? Explain cis-trans, E-Z, syn-anti configurations with examples. (C1 & C2)	6
Unit 9:		
Green Chemistry	• Define green chemistry (C1) • Discuss 12 principles of green chemistry (C1, C2)	6

	• Explain green preparation with at least two examples for each methods. (Aqueous phase reactions, solid state (solventless) reactions, photochemical reactions, Phase transfer catalyst catalysed reactions, enzymatic transformations & reactions in ionic liquids) (C2) • List the advantages and shortcomings of each method (C1)	

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with Cos

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x			
Quiz						
Assignment/Presentation		x		x	x	
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Bruice, PY Essential Organic Chemistry, Pearson Education. 2007. • Clayden, J. Greeves, N and Warren, S. Organic Chemistry,(Second Edition), Oxford University Press. • Sanghi R & Srivatsava, M.M, Green Chemistry-Environment friendly alternatives, Narosa Publishing House, 2003. • Tomasz, P. Jerzy, L. Mark T. Recent Advances in QSAR Studies, Methods and Applications, 1st Edition, Springer, 2010. • Puri B R, Sharma, LR and Pathania, MS. Principles of Physical Chemistry, Vishal Publishing Co, 2019. • Glasstone S. Thermodynamics for Chemists, , East-West Pvt Ltd, 2002.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Computer Science (Theory)**
Course Code: BBT 109	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 3	**Prerequisites: Admission to B.Sc. program**

Synopsis:	This course will provide fundamental knowledge of various operating systems such as Windows and Linux and introduce students to the application software for data documentation and analytics.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Make use of different operating systems like Windows and Linux (C1, C2, C3)
CO 2:	Utilize application software like Microsoft Office Word, PowerPoint, Excel (C1,C2)
CO 3:	Develop web pages (C2, C3)
CO 4:	Formulate PERL scripts for sequence feature extraction (C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	X					X				X					
CO 2	X		X	X				X		X					
CO 3	X							X		X					
CO 4	X									X					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction to computer, basic units, hardware and software and its applications, different types of computers	• Understand the basic parts of computer (C1)	6
Unit 2:		
Windows and Linux operating systems, installation of application softwares	• Learn the operation of operating systems, installation of application softwares (C1, C2)	10
Unit 3:		
Microsoft Office application tools: Excel, Word, PowerPoint	• Understand the data documentation, analysis, and presentation (C1, C2)	9
Unit 4:		
HTM: usage of HTML tags, designing webpages and online forms Hyperlinks	• Understand the concepts in web designing and internet applications (C2, C3)	10
Unit 5:		
Scripting Language - PERL Concepts of programing language, importance of PERL, data types, variables, data structures and operators, file management and pattern matching, strings and Regular expression.	• Formulate PERL scripts for feature extraction from biological sequences (C2, C3).	10

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-

TOTAL	**50**	**135**
Assessment Methods:		
Formative:	**Summative:**	
Class tests	Sessional examination	
Assignments/presentations	End semester examination	
Quiz		

Mapping of assessment with COs				
Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination	X	x	x	
Quiz	NA	NA	NA	NA
Assignment/Presentation	X	x	x	x
End Semester Examination	X	x	x	x
Laboratory examination	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Computer for Beginners. 1985. R. Thiagarajan, Stosius Inc/Advent Books Division. • Introduction to Computers: Fundamentals of Computer Sciences. 1986. Subramaniam N., Tata-McGraw Hill Publishing. • Introduction to Computer Science. 2015. Savitha Balamurali, Vikas Publishing House (P) Ltd. • Beginning PERL for Bioinformatics. 2001. Tisdall J., O'Reilly Publications. • Computer Fundamentals: Architecture and Organization (3rd Eds.). 2000. Ram B., New Age International Publishers. • HTML: The complete reference (2nd Eds.). 1999. Thomas A. Powell, The McGraw-Hill Companies.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biology-I (Practical)**
Course Code: BBT 111	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 1	**Prerequisites: Admission to B.Sc. program**
Synopsis:	The objectives of this course are to acquaint the students with morphological differences between organism and their adaptation to environment; to acquire skills to use dissecting microscope to mount different body parts of *Drosophila*; to understand the anatomy of reproductive system of lower organisms; to know about the model organisms and its uses.

Course Outcomes (COs):	At the end of the course student shall be able to:
CO 1:	Demonstrate the basic knowledge and skills of identifying and classifying the museum specimens based on morphological characters (P1, P2)
CO 2:	Obtain skill related to maintaining the *Drosophila* (P1)
CO 3:	Demonstrate the skills in mounting *Drosophila* wing, egg, and identification of male and female fly (P2, P3)
CO 4:	Display knowledge about the use of model organisms and their identification (P2)
CO 5:	Demonstrate the skills to dissect the reproductive system of *Drosophila* (P2, P3)
CO 6:	Demonstrate vertebrate dissections using online tools (P1, P2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														

CO 3	×														
CO 4	×					×									
CO 5	×														
CO 6	×									×					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Museum specimens	To understand the taxonomic level and morphology (P1, P2)	6
Unit 2:		
Drosophila maintenance	To collect and culture *Drosophila* flies and to be able to identify male and female (P1, P2)	2
Unit 3:		
Mounting of egg, larvae, wing, sex comb of Drosophila	Learn to use dissection microscope and mount egg, wing, sex comb of *Drosophila* (P2, P3)	2
Unit 4:		
Dissection of reproductive system of Drosophila	Skills to dissect male and female *Drosophila* reproductive system using dissection microscope (P2, P3)	6
Unit 5:		
Model organisms	Learn to identify and understand the use of model organisms (P2)	4
Unit 6:		
Culture and mounting of Paramecium	To detect and identify the *Paramecium,* Culturing of *Paramecium* (Protozoan culture) (P1, P2)	4
Unit 7:		
Vertebrate dissections	Explain the anatomy of internal organ systems of mice (using online/computer documents including videos; images) (P2, P3)	4
Unit 8:		
Visit to animal house	To understand the basic requirements of laboratory animal breeding and maintenance (P1, P2)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	x	x	x		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	X	NA	NA	x	NA	NA
End Semester Examination						
Laboratory examination	X	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• S. S. Lal, Practical Zoology, Invertebrate. S. S. Lal. Rastogi Pub, India. • S. S. Lal, Practical Zoology, Vertebrate. S. S. Lal. Rastogi Pub, India. • Farzana Khan Perveen. Introduction to *Drosophila, Drosophila melanogaster*, IntechOpen, 2018. • Ghosh, K.C. and Manna, B.: Practical Zoology, New Central Book Agency, Kolkata, 2015

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biology-II (Practical)**
Course Code: BBT 113	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 1	**Prerequisites: Admission to B.Sc. program**
Synopsis:	This module helps to gain knowledge in basic courses of Botany. It aims to provide fundamental knowledge of plant morphology, taxonomy, anatomy, physiology & biochemistry and pathology; and to understand the fundamental forms of flora and their diversity.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Outline the methods for plant identification using morphological traits
CO 2:	Demonstration of various methods to understand the morphological adaptations
CO 3:	Learning methods to understand the biochemical and physiological process via anatomy. Conclude the role of physiology in deciphering plant efficiencies.
CO 4:	Explain the fundamentals of plant anatomy, reproductive biology and crop improvement strategies
CO 5:	Discuss and illustrate the various anatomical differences in plant tissues Learning to establish chromosome numbers in plants
CO 6:	Discuss the nature of cellular architecture and exclusive features Comparative analysis of monocot vs dicot tissues and their differences and oddities

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	×													
CO 2	×	×													
CO 3	×	×													
CO 4	×	×		×											
CO 5	×	×													
CO 6	×	×								×					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Study of microscope	• Outlining the parts of microscope (C1, C2, C5) • Estimation of resolution power of various microscopes (C5)	2

	• Discuss on the types of microscopes and respective utility in understanding plant parts (C6)	
Unit 2:		
Microscopic observation of transverse section of a dicot & Monocot leaf	• Classify the types of dicot and monocot leaves and their adaptational variations (C2, C4) • Estimate and compare the performance of dicot & monocot plant leaves based on their anatomical features (C5, C6)	4
Unit 3:		
Microscopic observation of transverse section of a dicot & Monocot stem	• Classify the types of dicot and monocot stem and their adaptational variations (C2, C4) • Estimate and compare the performance of dicot & monocot plant stems based on their anatomical features (C5, C6)	4
Unit 4:		
Microscopic observation of transverse section of a dicot & Monocot root	• Classify the types of dicot and monocot roots and their adaptational variations (C2, C4) • Estimate and compare the performance of dicot & monocot plant root based on their anatomical features (C5, C6)	4
Unit 5:		
Study of effect of quality of light on photosynthesis	• Demonstrate and analyze the photosynthetic rates in plants with respect to light quality (C2, C4)	4
Unit 6:		
Study of effect of quantity of light on photosynthesis	• Explain & Demonstrate and analyze the photosynthetic rates in plants with respect to light quantity (C2, C4)	2
Unit 7:		
Study of plasmolysis using potato cylinders	• Illustrate and analyze the plasmolysis intensity in plant cells treated with solution tonicity's (C2, C4)	2
Unit 8:		
Observation of transpiration using Ganong's potometer	• Analyze the transpiration rates in plants at different environmental conditions and compute the results (C4, C5)	4
Unit 9:		
Mitosis in Allium cepa & Meiosis in plants	• Explain, discuss and demonstrate the mitotic stages in Allium cepa roots and compute the active mitotic index (C2, C6) • Explain, discuss and demonstrate the meiotic stages in plants and estimate the active meiotic index (C2, C6)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:		
Formative:		**Summative:**
Class tests		Sessional examination
Assignments/presentations		End semester examination
Quiz		

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x	x		
Quiz						
Assignment/Presentation	x				x	
End Semester Examination						
Laboratory examination	x	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• A Stock Book of Biology Vol. I - 2002 - M Sudhakar Rao, - Geetha Publishers, Mysore. • Biological Science (3rd Ed.) - 2002 - Taylor DJ, Green NPO, Stout GW - Cambridge University Press. • Biological Science (3rdEd) - Taylor DJ, Green NPO, Stout GW. - 2002 - Cambridge University Press. • Biology –2002- Chakroborty DP, National Council of Educational Research & Training, India. • Fundamentals of Plant Physiology - 1977 - Jain VK, - S Chand Publishers, New Delhi. • Introduction to principles of Plant Taxonomy – 1991 – VV Sivarajan, • Plant Physiology – 1992 - Salisbury FB, Ross CW - Wadsworth Publishers, UK. • Plant Physiology (5th Ed.) – 2010 - Taiz L, Zeiger E. - Sinauer Associates.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Chemistry (Practical)**
Course Code: BBT 115	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 1	**Prerequisites: Admission to B.Sc. program**
Synopsis:	This practical course introduces and provides knowledge and technical skills in chemistry.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	List and illustrate the basic methods in neutralisation titrations (P1, P2)
CO 2:	Estimate the hardness of given sample of water (P1, P2)
CO 3:	Demonstrate the synthesis of salicylic acid using ethyl salicylate (P1, P2)
CO 4:	Demonstrate precipittion titration with its applications (P1, P2)
CO 5:	Estimate the amount of acetone and vitamin C using redox titration (P1, P2)
CO 6:	Applications of neutralisation titration such as finding the purity of given sample of acetic acid, estimating the amount of glycine (P1, P2)

Mapping of COs to POs

Cos	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×			×											
CO 2	×			×											
CO 3	×							×							

CO 4	×							×							
CO 5	×							×							
CO 6	×			×				×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Acid-base titrations – Acidimetry, Alkalimetry	• To list three uses for acid-base titrations.(P1) • To describe the difference between an "endpoint" and an "equivalence point" in an acid-base titration. (P1) • Explain, by using chemical equations, the chemical change(s) that occur during a strong acid/strong base titration. (P2)	2
Unit 2:		
Estimation of total hardness of the given sample of water	• Compare hard water and soft water (P1, P2) • Demonstrate the chelation reactions of metal ions (P1, P2) • Explain the concept of complexometric titration (P1, P2)	4
Unit 3:		
Precipitation titration and its application in determining the chloride content of water	• Analyse the chloride content of given water (P1, P2) • Demonstrate the precipitation titration using Fajan's method and mohrs method (P1, P2)	4
Unit 4:		
Preparation of Salicylic acid from methyl salicylate by Hydrolysis	• Define the alkali hydrolysis (P1) • How the theoretical yield is calculated? (P1, P2) • Write the reaction involved in the hydrolysis of methyl salicylate (P1) • Demonstrate the technique to find the melting point of sample (P1, P2)	4
Unit 5:		
To determine ascorbic acid (vitamin C) concentration by a redox titration with N-bromosuccinamide	• Define redox titration (P1) • Write the reaction for oxidation of vitamin C (P2) • Determine the vitamin C concentration in the given sample (P1, P2)	4
Unit 6:		
Determination of the amount of Acetone by Iodoform method	• Illustrate the concept of back titration(P1, P2) • Write the reaction between acetone and iodine (P1, P2) • Explain the concept of iodometric titration. (P2)	4
Unit 7:		
Determination of the percentage purity of Acetic acid by titration method.	• Assess the purity of given sample of acetic acid (P1, P2) • Demonstrate to prepare standard solutions of primary standard (P1, P2)	2
Unit 8:		
Estimation of glycine.	• Estimate the quantity of glycine present in given solution (P1, P2) • Write the reaction between glycine and formaldehyde(P1, P2)	2
Unit 9:		
Determination of i) Acid value ii) Iodine value of the given sample of oil/fat.	• Demonstrate the experiment for the analysis of oil (P1, P2) • Explain the significance of acid value and iodine value (P1, P2)	2
Unit 10:		

To check the purity of given sample	• Demonstrate recrystallization of given crude sample (P1, P2) • Find the melting point of given sample (P1, P2) • Find the boiling point of given sample (P1, P2)	2

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x	x		
Quiz						
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination						
Laboratory examination	x	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	•Vogel's Textbook of Practical Organic Chemistry. London: Longman Scientific & Technical, 1989. •Practical Organic Chemistry: FG Mann, BC Saunders, New York Longmann.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Computer Science (Practical)**
Course Code: BBT 117	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, I Semester**
No of Credits: 1	**Prerequisites: Admission to B.Sc. Program**
Synopsis:	This practical course provides knowledge and skills in computer science
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Operate Linux and Windows operating systems (C1, P7)
CO 2:	Make use of Microsoft application software such as Word, Excel, PowerPoint (P2, P4)
CO 3:	Design web pages and online forms (P1, P4,P7)
CO 4:	Write and execute Perl scripts for biological sequence data analysis (P1,P2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	X									X					

CO 2	X		X	X	X					X					
CO 3	X									X					
CO 4	X			X	X	X		X		X					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Operating systems: Windows and Linux, Installation of application softwares, Linux commands,	• Demonstration of OS, different types of OS and working environment with terminal/command prompt (P1, P2)	9
Unit 2:		
Microsoft Office: Word, Excel, PowerPoint	• Formulas, functions, different types of functions, insert charts and draw figures and charts (P1,P3)	7
Unit 3:		
HTML and Web Design	• Designing the web pages, creating online forms(P2, P3)	7
Unit 4:		
PERL	• Formulate PERL scripts for feature extraction from biological sequences (P2, P3, P4)	7

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination	x	x	x	
Quiz	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x
End Semester Examination				
Laboratory examination	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Introduction to Computer Science. 2015. Savitha Balamurali, Vikas Publishing House (P) Ltd. • Beginning PERL for Bioinformatics. 2001. Tisdall J., O'Reilly Publications.

	• Computer Fundamentals: Architecture and Organization (3rd Eds.). 2000. Ram B., New Age International Publishers. • HTML: The complete reference (2nd Eds.). 1999. Thomas A. Powell, The McGraw-Hill Companies. • W3School (https://www.w3schools.com/)

Name of the Program:								**B.Sc. Biotechnology (Honours)**							
Course Title:								**Seminar/Journal Club**							
Course Code: BBT 119								**Course Instructor: Course In-charge**							
Academic Year: 2023 onwards								**Semester: I Year, I Semester**							
No of Credits: 1								**Prerequisites: Admission to B.Sc. program**							
Synopsis:	This course will include an allotment of an individual seminar topic related to the semester courses. This will enhance students' knowledge base and expose them to how to present information clearly and concisely. Students will also learn how to compile the literature database information.														
Course Outcomes (COs):	On successful completion of this course, students will be able to														
CO 1:	Express thoughts and ideas effectively														
CO 2:	Demonstrate the ability to listen carefully and react														
CO 3:	Apply one's views and present complex information clearly and concisely to different groups														
CO 4:	Conclude on information														
CO 5:	Define the problem in a concise manner														
CO 6:	Adopt challenging tasks; students will also learn how to compile and interpret data														
Mapping of COs to POs															
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×													
CO 4		×													
CO 5		×													
CO 6		×													

Course content and outcomes:		
Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual seminar topic related to the semester courses	30-minute oral presentation for each student

Learning strategies, contact hours, and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	15	45
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		

Assessment	01	-
TOTAL	**16**	**45**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	-

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference books and Journals articles related to the seminar topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Cell Biology (Theory)**
Course Code: BBT 102	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 3	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	The objectives of this course are to acquaint the students with basic structure of cell and its components. To provide fundamental knowledge on the structure and function of cell organelles; To understand the functions cell division, process of cell cycle regulation, protein transport; To discuss various theories of origin of life, evolution with discussion on evidences

Course Outcomes (COs):	At the end of the course student shall be able to: -
CO 1:	Learn the differences between virus, bacteria and plant and animal cells (C1, C2)
CO 2:	Illustrate and discuss the important cell organelles and their functions (C1, C2)
CO 3:	Understand the process of protein sorting (C2, C3)
CO 4:	Learn to explain the process involved in mitosis and meiosis and to understand the differences between them and explain the cell cycle and its regulation (C1, C2)
CO 5:	Understand, categorize and compare various types primary tissues and their functions (C2, C3)
CO 6:	Understand the various theories of origin of life, evolution and appraise evidences supporting it the with (C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×		×												
CO 3	×		×												
CO 4	×		×												
CO 5	×		×												
CO 6	×		×												

Course content and outcomes:

Content	*Competencies*	*No of Hours*

Unit 1:		
Basic organization of the cell	Comparison between bacteria, plant, and animal cells (C1, C2)	3
Unit 2:		
Structure and functions of cell organelles	Describe the Golgi, plasma membrane, junctional complex, nucleus, mitochondria, chloroplast, endoplasmic reticulum, lysosomes, peroxisomes, cytoskeleton, centriole, ribosome (C1, C2)	19
Unit 3:		
Protein sorting and transport	Explain the signal sequence, protein sorting to organelles (Endoplasmic reticulum, mitochondria, nucleus, peroxisome) and the secretory pathways (C2, C3)	5
Unit 4:		
Cell division and Cell cycle	Understand the phases of cell cycle, cell cycle check points, cell cycle regulation Describe the Mitosis- Mechanism, molecular organization and functional role of mitotic apparatus, cytokinesis in animals and plant cells Meiosis: Mechanism, pairing and synaptonemal complex, crossing over, significance of meiosis (C2, C3)	6
Unit 5:		
Histology	Explain the type, structure, and function of epithelial, connective, muscular and nervous tissue (C2, C3)	5
Unit 6:		
Origin of life and Evolution	Describe the theories and experiments on the origin of life, theories of evolution - Lamarckism, Darwinism, Mutation theory, Neo-Darwinism. Evidences for evolution with special emphasis on molecular evolution (C1, C2, C3)	7

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6

Sessional Examination	x	x	x			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Alberts Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter Molecular Biology of the Cell, Garland Science, 2007. • Lodish H, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira P, Molecular Cell Biology, WH Freeman 2007. • Ross MH, Pawlina W. Histology: A text and atlas: with correlated cell and molecular biology, Baltimore MD, Lippincott Wiliams & Wilkins, 2006 • Karp G, Cell and Molecular Biology - Concepts and experiments, 2010, John Wiley and Sons, 2010. • Brian Hall et al. Strickberger's evolution. Jones & Bartlett Learning, 2008.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biochemistry (Theory)**
Course Code: BBT 104	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 3	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	This course introduces and provides knowledge in field of biochemistry. To provide insight into the chemistry and metabolism of biomolecules, fundamental knowledge about the enzymes and vitamins and to understand the mechanism of electron transport chain and acid base balance.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the chemistry of carbohydrates and lipids (C1, C2, C3, C4, C6)
CO 2:	Explain the process of metabolism of carbohydrates and lipids (C1, C2, C3, C4, C5, C6)
CO 3:	Discuss the mechanism of electron transport chain and acid base balance (C1, C2)
CO 4:	Explain the basic principle of Fluid Mosaic model of membrane and understand the transport mechanism via cell membrane. (C1, C2, C4)
CO 5:	Classification of enzymes and the role of metal ions and coenzymes in activity of enzymes, understand the regulation mechanism and factors affecting the enzyme activity (C1, C2, C3, C4)
CO 6:	Describe the function and role of vitamins in normal physiology and disease (C1, C2, C3, C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	×													
CO 2	×	×	×												
CO 3	×	×	×	×											
CO 4	×	×	×												
CO 5	×	×	×												
CO 6	×	×	×	×											

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		

Chemistry of carbohydrates	• Classify carbohydrates and list its isomeric forms (C1, C2) • Distinguish between reducing and nonreducing, aldoses and ketoses, homo and heteropolysaccharides (C1, C4) • Elaborate on the composition of homopolysaccaharides and heteropolysaccharides (C1, C2, C6) • Explain the reactions of carbohydrates –osazone formation, glycosidic linkage, reduction and oxidation of monosaccharides (C1, C2, C3, C4)	4
Unit 2:		
Chemistry of lipids	• Classify lipids and elaborate on its composition and function (C1, C2, C4) • Functions, composition and characteristics of cholesterol and prostaglandins(C1, C2) • Functions, composition and characteristics of monounsaturated fatty acids and polyunsaturated fatty acids(C1, C2)	3
Unit 3:		
Membrane structure and transport across membranes	• Explain the fluid mosaic model of membranes (C1, C2) • Functions and characteristics of membrane proteins (C1, C2, C4) • Explain facilitated diffusion with examples (C1, C2) • Explain active transport with examples (C1, C2)	3
Unit 4:		
Enzymes	• Classify enzymes with a note on its EC numbering system (C1, C2) • Importance of cofactors, metal ions and coenzymes in activity of enzymes(C1, C2, C3) • Explain the regulations and mechanism of enzyme activity(C1, C2, C3, C4) • What is diagnostic enzymology? (C1, C2)	7
Unit 5:		
Metabolism of carbohydrates	• Explain digestion and absorption of carbohydrates(C1, C2, C3) • Explain the reaction of glycolysis. Add a note on its regulation and energetics(C3, C4, C5) • Discuss in detail Krebs cycle and its amphibolic role (C1, C2, C3, C4, C5, C6) • Explain gluconeogenesis and its regulation(C2, C3, C4) • Explain glycogen metabolism and disorder associated with it (C1, C2,C3, C4, C5, C6) • Discuss the significance of pentose phosphate pathway? (C1, C2, C3, C4) • Explain galactose metabolism (C1, C2, C3)	6
Unit 6:		
Metabolism of lipids	• Discuss beta oxidation and fatty acid synthesis(C1, C2, C6) • Define ketone body metabolism and ketoacidosis (C1) • What are the functions of serum cholesterol? (C1) • Classify lipoproteins with a note on its composition and function (C1, C2)	6
Unit 7:		
ETC and Oxidative phosphorylation	• What are high energy compounds? (C1) • Explain components of electron transfer chain (C1, C2) • Define chemiosmotic hypothesis (C1) • Discuss ATPase complex (C1, C2)	6
Unit 8:		
Acid Base Balance	• What are different blood buffers? (C1)	3

	• Discuss the role of lung and kidney in maintaining acid base balance (C1, C2, C3, C4, C5, C6) • What is anion gap? (C1)	
Unit 9:		
Vitamins	• Classify vitamins Add a note on functions and deficiency of water soluble vitamins (C1, C2) • What are the sources, requirements, function, deficiency, hyper vitaminosis with respect to vitamin A? (C1, C2, C3, C4) • What are the sources, requirements, function, deficiency, hyper vitaminosis with respect to vitamin D? (C1, C2, C3, C4) • What are the sources, requirements, function, deficiency, hyper vitaminosis with respect to vitamin E and K? (C1, C2, C3, C4) • What are the sources, requirements, function, deficiency, hyper vitaminosis with respect to vitamin C? (C1, C2, C3, C4)	7

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x	x		
Quiz						
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Biochemistry: D Voet and JE Voet, 4th Edition, 2011 John Wiley and Sons.ISBN:978-1-1180-25024. • Textbook of Biochemistry for Medical Students: DM Vasudevan, S Sreekumari and K Vaidyananthan 6th edition, 2011, Jaypee Medical Publishers, New Delhi. ISBN 978.93-5025-016-7.

	• Biochemistry: JM Berg, JLT Tymoczko and L Stryer, 7th edition 2012, WH Freeman and Co., New York.ISBN.13:978-1-4292-7635-1. • Biochemistry : U Satyanarayana and U Chakrapani 5th edition, 2019, Books & Allied Pvt Ltd., Kolkata. ISBN.13 : 978-8131236017.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Environmental Science (Theory)**
Course Code: BBT 106	**Course Instructor: Course in-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 3	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	The objective of this course is to acquaint the students with fundamentals of environmental sciences, provide basic knowledge of ecosystem, resources, biodiversity, conservation and environmental pollution. Further, to understand the role of human communities on the environment, policies and practices.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Define environment, its scope and explain the human-environment interactions, natural resources and sustainable development (C1, C2, C3)
CO 2:	Explain the various environmental issues and the measures for conserving biodiversity and resources (C1, C2, C4)
CO 3:	Define environmental pollution, describe its health impact (C1, C2, C3)
CO 4:	Explain climate change and different environmental management practices (C2, C3)
CO 5:	List and describe the various national and international environmental legislations and treaties (C1, C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×														
CO 4	×			×											
CO 5	×			×											

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Humans and Environment – man-environment interactions (Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of city-states; Great ancient civilizations and the environment; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change), The emergence of environmentalism (Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and the concept of sustainable development; Rio Summit and subsequent international efforts)	• Describe historical context of human interactions with environment (C1, C2) • Discuss the international efforts to safeguard earth's environment and resources (C1, C2)	4
Unit 2:		

Natural Resources and Sustainable Development - Definition of resource; Classification of natural resources- biotic and abiotic, renewable and non-renewable; major types of biotic resources, microbes as resource; water resources; soil and mineral resources; energy resources; Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs	• Explain concept of natural resources, types, distribution and use with specific reference to India, factors affecting availability of natural resources and their conservation and management (C1, C2, C3) • Define sustainable development and describe its goals, targets, challenges and global strategies (C1, C2, C4)	6
Unit 3:		
Environmental Issues: Local, Regional and Global - Environmental issues and scales: Concepts of micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena. Pollution: Impact of sectoral processes on Environment, Types of Pollution- air, noise, water, soil, municipal solid waste, hazardous waste; Transboundary air pollution; Acid rain; Smog. Land use and Land cover change: land degradation, deforestation, desertification, urbanization. Biodiversity loss: past and current trends, impact. Global change: Ozone layer depletion; Climate change.	• Explain the environmental issues of concern (C2, C3) • Explain the concepts of spatial and temporal scales and their importance (C1, C2, C3) • List and describe the sectoral effects on the local, regional and global environmental issues (C1, C2, C3)	6
Unit 4:		
Conservation of Biodiversity and Ecosystems - Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories. Ecosystems and ecosystem services: Major ecosystem types in India and their basic characteristicsforests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance. Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change. Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; gender and conservation.	• Define concepts of ecosystem, biodiversity and conservation (C1, C2) • Describe the main types of ecosystems and their distribution in India and the world (C1, C2, C4) • Discuss factors impacting biodiversity loss and ecosystem degradation in India and the world (C1, C2, C4) • Explain conservation of biodiversity and major conservation strategies taken in India (C2, C3)	6
Unit 5:		
Environmental Pollution and Health - Understanding pollution: Production processes and generation of wastes; Assimilative capacity of the environment; Definition of pollution; Point sources and non-point sources of pollution. Air pollution: Sources of air pollution; Primary and secondary pollutants; Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter and	• Discuss different types (air, water, soil, chemical, thermal, radioactive and noise), causes, adverse effects and control of pollution (C1, C2, C3)	6

sulphur dioxide; Other important air pollutants- Volatile Organic compounds (VOCs), Peroxyacetyl Nitrate (PAN), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); Indoor air pollution; Adverse health impacts of air pollutants; National Ambient Air Quality Standards. Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life. Soil pollution and solid waste: Soil pollutants and their sources; Solid and hazardous waste; Impact on human health. Noise pollution: Definition of noise; Unit of measurement of noise pollution; Sources of noise pollution; Noise standards; adverse impacts of noise on human health. Thermal and Radioactive pollution: Sources and impact on human health and ecosystems		
Unit 6:		
Climate Change: Impacts, Adaptation and Mitigation - Understanding climate change: Natural variations in climate; Structure of atmosphere; Anthropogenic climate change from greenhouse gas emissions– past, present and future; Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent. Impacts, vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health, urban infrastructure; the concept of vulnerability and its assessment; Adaptation vs. resilience; Climate-resilient development; Indigenous knowledge for adaptation to climate change. Mitigation of climate change: Synergies between adaptation and mitigation measures; Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; National and international policy instruments for mitigation, decarbonizing pathways and net zero targets for the future; Energy efficiency measures; Renewable energy sources; Carbon capture and storage, National climate action plan and *Intended Nationally Determined Contributions* (INDCs); Climate justice.	• Explain climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture (C2, C3) • Explain methods of mitigating climate change effects including carbon neutrality, renewable energy resources (C2, C3)	6
Unit 7:		
Environmental Management - Introduction to environmental laws and regulation: Constitutional provisions- Article 48A, Article 51A (g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control.	• Discuss importance of environmental laws and regulations	5

Environmental management system: ISO 14001 Life cycle analysis; Cost-benefit analysis Environmental audit and impact assessment; Environmental risk assessment Pollution control and management; Waste Management-Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme	• Explain the impact of environmental management systems • Describe life cycle and cost benefit analyses, environmental audit, impact and risk assessments. • Explain pollution control, waste management principles including 3R concept, sustainability, ecolabeling/ecomark scheme	
Unit 8		
Environmental Treaties and Legislation - An overview of instruments of international cooperation; bilateral and multilateral agreements; conventions and protocols; adoption, signature, ratification and entry into force; binding and non-binding measures; Conference of the Parties (COP); Major International Environmental Agreements: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing; Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India's status as a party to major conventions Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules; Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone; Status phase-out of production and consumption of Ozone Depleting Substances by India; National Green Tribunal; Some landmark Supreme Court judgements	• Explain how nations work together for the environment • Describe the global treaties and agreements towards environmental safeguards • Describe Indian laws and regulations for environment	6

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination	x	x	X	x	
Quiz					
Assignment/Presentation		x	X	x	x
End Semester Examination	x	x	X	x	x
Laboratory examination	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press • Headrick, Daniel R. (2020) Humans versus Nature- A Global Environmental History, Oxford University Press • Hughes, J. Donald (2009) An Environmental History of the World- Humankind's Changing Role in the Community of Life, 2nd Edition. Routledge • Perman, R., Ma, Y., McGilvray, J., and Common, M. (2003) Natural Resource and Environmental Economics. Pearson Education • Simmons, I. G. (2008). Global Environmental History: 10,000 BC to AD 2000. Edinburgh University Press • John W. Twidell and Anthony D. (2015). Renewable Energy Sources, 3rd Edition, Weir Publisher (ELBS) • Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications https://sdgs.un.org/goals • Harper, Charles L. (2017) Environment and Society, Human Perspectives on Environmental Issues 6th Edition, Routledge • William P. Cunningham and Mary A. (2015). Cunningham Environmental Science: A global concern, Publisher (Mc-Graw Hill, USA) • Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press. • Sinha, N. (2020) Wild and Wilful. Harper Collins, India • Varghese, Anita, Oommen, Meera Anna, Paul, Mridula Mary, Nath, Snehlata (Editors)

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- Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK
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Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Physics (Theory)**
Course Code: BBT 108	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 3	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	The objective of this course is to acquaint the students with basic Physics principles- to provide fundamental knowledge of vectors, scalars, mechanics, electricity, magnetism, superconductor, semiconductor properties etc. To understand the functions of the optics and their applications.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Solve the problems of vector analysis including addition, subtraction and multiplication (C2, C3)
CO 2:	Explain the various optical phenomenon including interference, diffraction, polarization (C2, C5)
CO 3:	Explain electricity and magnetism through various classical laws and experiments (C2, C5)
CO 4:	Compare types of semiconductors and their applications in electronics devices including, diodes, transistors, amplifiers, rectifiers etc (C4)
CO 5:	Explain the conductivity of solids including super conductors (C2, C6)
CO 6:	Explain the basic principle of BCS theory, Meissner effect (C2, C5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×														
CO 4	×				×										

CO 5	×								×						
CO 6	×								×						

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction to mechanics	• Identify scalars, vectors, co-ordinate systems (C3) • Solve for sum, difference and product of vectors (C3, C5)	3
Unit 2:		
Introduction to interference phenomenon	• Explain interference using Young's experiment (C2, C5) • Interpret thin film interference and band width of interference fringes (C2, C4) • Explain Newton's rings, Michelson interferometer (C2, C6)	4
Unit 3:		
Introduction to diffraction phenomenon	• Illustrate Fresnel & Fraunhoffer diffraction (C2, C5) • Interpret Fraunhoffer diffraction at single slit (C2, C4) • Explain Diffraction grating and its dispersive and resolving powers (C2, C5)	4
Unit 4:		
Basics of polarization and applications	• Illustrate basics of polarisation (C2, C5) • Explain Brewster's law, birefringence (double refraction), Nicol prism, quarter and half wave plates (C2, C4) • Compare types of polarized lights (C4) • Explain optical activity and working principles of Half-Shade Polarimeter (C2, C6)	4
Unit 5:		
Introduction to electricity and magnetism, principles of electron microscope	• Explain the electricity and magnetism using Coulomb's law, Gauss law, Ampere's law, Biot-Savart's law (C2, C5) • Compare the motion of electrons in electric & magnetic fields (C4) • Explain the working principles of Hall Effect, cathode ray oscilloscope (CRO), Aston mass spectrograph, Electron microscope (C2, C4, C5)	8
Unit 6:		
Introduction to Faraday's law and applications; Maxwell's equations	• Explain Faraday's laws of electromagnetic induction, self and mutual inductance (C2, C5) • Outline the basic principles of transformer and LCR resonance circuits, electrodynamics (C2, C4) • Explain Maxwell's equations (C2, C3)	6
Unit 7:		
Basics of solids and working principle of semiconductors	• Identify energy bands in solids (C3) • Fermi concept, types of semiconductors (C2, C5) • Outline the relationship between band gap, conductivity and temperature in semiconductors (C2, C4)	6
Unit 8:		
Applications of semiconductors	• Compare the junction diodes, LED, Zener diode, transistors (C4) • Demonstrate the transistor as R.C coupled amplifier, diode as a full wave rectifier (C2, C5)	6
Unit 9:		

Introduction to electrical conductivity in solids and applications	• Interpret the effect of temperature and impurities on conductivity/resistivity of conductors (C2, C4) • super conductors, BCS theory, Meissner effect (C2, C5)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	×	NA	×	NA	×	NA
End Semester Examination	×	×	×	×	×	×
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Young, Hough D., Freedman, Roger A., Ford, Lewis. University Physics-International student edition, Boston, Addison Wesley, 1996. • Ewing, Galen W. Instrumental Methods of Chemical analysis, New York, McGraw Hill, 1975. • Skoog, Douglas A., West, Donald M., Holler, F James. Fundamental of Analytical Chemistry, Canada, Nelson Education, 1996 • Basavaraju SP. Engineering Physics, Bangalore, Subhash Book Stores, 2018 • Das, Debojyoti. Bio-Physics and Bio-Physical Chemistry, Calcutta Academic Publishers, 2007. • Halliday, David., Resnick, Robert., Walker, Jearl. Fundamental of Physics, New Jersey, John Wiley & Sons Inc., 2008. • Jenkins, Francis A., White, Harvey E. Fundamental of Optics, New York, McGraw – Hill, 2001.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Advanced Chemistry (Theory)**
Course Code: BBT 110	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 3	**Prerequisites: Qualified I semester as per university guidelines**

Synopsis:	This course introduces and provides knowledge in chemistry techniques such as spectroscopy, detection and estimation of elements. The course discusses structure and properties of proteins.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the working principle and applications various spectroscopic techniques (NMR, IR spectroscopy, microwave spectroscopy) (C1, C2, C3, C4)
CO 2:	Explain the techniques of polymerisation, fabrication of scaffolds and characterisation methods (C1, C2, C3)
CO 3:	Discuss the qualitative analysis and quantitative analysis of elements such as carbon, hydrogen, nitrogen, halogens and sulphur in the given organic compound (C1, C2, C3, C4) Discuss various purification techniques (C1, C2)
CO 4:	Discuss the Werners theory of coordination compounds, valence bond theory and nomenclature of coordination compounds (C1, C2, C3, C4)
CO 5:	Discuss the titrimetric methods of analysis (C1, C2)
CO 6:	Explain the chemistry and structures of proteins (C1, C2, C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×			×											
CO 2	×														
CO 3	×			×											
CO 4	×														
CO 5	×														
CO 6	×		×	×											

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Spectroscopic Techniques	• Explain the principle of NMR spectroscopy, IR spectroscopy, microwave spectroscopy (C1, C2) • Discuss the applications of NMR spectroscopy (C1, C2, C3, C4) • Discuss the applications of UV spectroscopy (C1, C2, C3, C4) • Define chromphore, auxochrome, chemical shift (C1, C2) • Discuss the solvent effect in UV spectroscopy (C1, C2)	11
Unit 2:		
Biomaterials	• Classify polymers based on the structure, origin response to heat (C1, C2) • Discuss the techniques of polymerisation (C1, C2, C3) • Find the number average molecular weight and weight average molecular weight (C1, C2) • Explain the fabrication of scaffold (C1) • Discuss the characterisation of scaffolds (C1, C2)	8
Unit 3:		
Elemental analysis and separation methods	• Outline the reactions involved in the detection of nitrogen, sulphur and halogens from the Lassaignes extract (C1, C2, C3) • Estimate the percentage of nitrogen, carbon, hydrogen, sulphur and halogens in the given organic compound (C1, C2, C3, C4) • Discuss the various purification techniques such as steam distillation and chromatographic techniques(C1, C2)	7
Unit 4:		

Co-ordination Compounds and Bioinorganic chemistry	• Define ligand, chelate, (C1, C2) • Summarise the nomenclature of coordination compounds (C1, C2) • Discuss the biological role of alkali and alkaline earth metals (C1, C2, C3) • Explain the valence bond theory of coordination compounds (C1, C2, C3, C4) • List the limitations of valence bond theory of coordination compounds (C1, C2, C3, C4)	6
Unit 5:		
Analytical methods	• Explain the principle of different types of titrations (neutralization, precipitation, complex formation, red-ox) instrumental method (potentiometric titration, conductometric titrations) (C1, C2) • Comparison of instrumental and analytical titration methods. (C2)	4
Unit 6:		
Structure and Properties of Important Biomolecules	• Recall the structure of amino acids (C1) • Discuss primary, secondary, tertiary and quaternary structure of protein (C4) • Explain reactions, synthesis of amino acids (C1, C2) • Discuss the determination of primary structure (C4)	9

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x		x			
Quiz						x
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Skoog DA, West DM, Holler FJ, Crouch SR. Fundamentals of Analytical Chemistry (9th ed.), DA and others, Brooks/Cole – Thomson Learning, 2009.

	• Kalsi PS. Spectroscopy of Organic Compounds (6th ed.), New Age International, 2007. • Puri BR, Sharma LR, Kalia KC. Principles of Inorganic Chemistry (33rd ed.), Vishal Publications, 2001. • Bruice PY, Essential Organic Chemistry (7th ed.), Pearson Education, 2007. • Gowariker VR, Viswanathan NV, Sreedhar J, Polymer Science, New Age International, 1986.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Cell Biology (Practical)**
Course Code: BBT 112	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 2	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	This practical course helps to understand the fundamental knowledge and tools and practical applications of Cell Biology
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Observation of streaming movement (cyclosis) of chloroplast in the protoplasm of Hydrilla leaf (P1, P2, P3, P4)
CO 2:	Understanding the structure of animal cell and determining the size of the cells (P2, P4, P6, P8)
CO 3:	Understanding and estimating the various types of WBCs in blood (P1, P2, P4, P5, P6, P8)
CO 4:	Understanding and studying the various phases and structure cell division (P1, P2, P3, P4, P6)
CO 5:	Learning and understanding various changes occur in RBCs and study of PBMCs in blood (P1, P3. P4, P6)
CO 6:	Learning and understanding various tissues of human body. (P1, P2, P3, P4, P6, P8, P11)

Mapping of COs to POs

Cos	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	x		x		x		x							
CO 2	x	x		x		x		x							
CO 3	×	x	X	x			x	×							
CO 4	x	x		x	x	x		x			x				
CO 5	×	x	X	x		x		×		x					
CO 6	×		X	x		x		×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Preparation and observation of chloroplast in Hydrilla leaf	• Observation of streaming movement (cyclosis) of chloroplast in the protoplasm of Hydrilla leaf (P1, P2, P3, P4, P6, P8)	4
Unit 2:		
Study of a typical animal cell *i.e.* Human buccal mucosa cell	• Understanding the structure of animal cell (P1, P2, P4, P6, P8)	4
Unit 3:		
Measuring the size of cells	• Estimation of size of the cells (P1, P2, P3, P4, P7, P8)	8
Unit 4:		

Study of polymorphic nuclei in human blood cells and differential counting of WBCs	• Understanding and estimating the various types of WBCs in blood (P1, P2, P4, P5 P6)	8
Unit 5:		
Squash preparation of meiosis - *Poekilocerus pictus* testis	• Understanding and studying the various phases and structure cell division (P1, P2, P3, P4, P6, P8, P10)	8
Unit 6:		
Effect of hypotonic, hypertonic and isotonic medium on cells (RBCs)	• Learning and understanding various changes occur in RBCs (P1, P3. P4, P6, P8)	8
Unit 7:		
Isolation of PBMC from blood using gradient centrifugation technique	• Study of the PBMCs from blood (P1, P4, P6, P8, P9)	8
Unit 8:		
Principles of tissue fixation and staining. Identification of histological sections of mouse tissue (intestine, liver, kidney and testes)	• Learning and understanding the various tissues of human body (P1, P2, P3, P4, P6, P8, P11)	12

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	60	180
Revision		
Assessment	07	-
TOTAL	**67**	**180**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x	x		
Quiz						
Assignment/Presentation	x			x		
End Semester Examination						
Laboratory examination	x	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Dr. P S Verma & Dr. V K Agarwal.

	• Lichtenthaler 1987. Chlorophylls and carotenoids: Pigments of photosynthetic biomembranes. Methods of Enzymology, 148, 350-382.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biochemistry (Practical)**
Course Code: BBT 114	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 2	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	This practical course introduces and provides knowledge and technical skills in Biochemistry.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	To prepare Normal, Molar and buffer solution. Will be able to calculate the concentration (percentage, molarity and normality) of the solutions (P1, P2)
CO 2:	Identify the given carbohydrate sample, to differentiate monosaccharide and disaccharide, reducing sugar and non-reducing sugar, aldohexoses and ketohexoses (P1, P2, P3, P4)
CO 3:	Demonstration of protein precipitation reactions and the process of identifying the given protein sample (P1, P2, P3, P4)
CO 4:	To estimate and quantify glucose by Dinitrosalicylic method, GOD-POD method (P1, P2)
CO 5:	To estimate and quantify proteins by Biuret method and Folin – Lowry's method (P1, P2)
CO 6:	Analysis of kidney functioning To estimate the uric acid, urea and creatinine content in unknown sample (P1, P2)

Mapping of COs to POs

Cos	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×							×							
CO 2	×							×							
CO 3	×					×		×							
CO 4	×					×		×							
CO 5	×					×		×							
CO 6	×					×		×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction to Biochemistry practical – Normal, Molar, percent solutions preparation, buffer solution preparation and calculations	• Explain the calculation and preparation of normal, molar and percent solutions (P1, P2) • Explain the preparation of buffer solutions using hendersons equations (P1, P2)	8
Unit 2:		
Analysis of proteins: color reactions	• Demonstrate the color reactions of proteins (P1, P2, P3, P4)	8
Unit 3:		
Precipitation reactions of proteins	• Illustrate the precipitation reactions of proteins (P1, P2)	4
Unit 4:		
Reactions of monosaccharides, disaccharides & polysaccharides	• Identify the given carbohydrate sample (P1, P2)	8

	• Demonstrate the reactions to classify the sugar into reducing sugar and non-reducing sugar (P1, P2) • Illustrate the reactions to classify the monosaccharide into aldoses and ketoses (P1, P2)	
Unit 5:		
Identification of unknown carbohydrate	• Identify the carbohydrate by qualitative analysis(P1, P2, P3, P4)	4
Unit 6:		
Estimation of reducing sugar by Dinitro-salicylic acid method	• Analyse the reducing sugar content of the unknown sample by Dinitro-salicylic acid method (P1, P2)	4
Unit 7:		
Glucose estimation by glucose oxidase method	• Analyse the reducing sugar content of the unknown sample by glucose oxidase and peroxidase (GOD-POD) method (P1, P2)	4
Unit 8:		
Estimation of proteins by Biuret method	• Illustrate the quantity of protein of unknown sample by Biuret method (P1, P2) • Interpret the importance of abnormal plasma protein levels (P1, P2)	4
Unit 9:		
Estimation of proteins by Folin Lowry's method	• Illustrate the quantity of protein of unknown sample by Folin Lowry's method (P1, P2)	4
Unit 10:		
Estimation of blood urea by urease method	• Illustrate the quantity of blood urea of unknown sample by urease method (P1, P2) • Interpret the importance of abnormal urea levels with respect to renal function test (P1, P2)	4
Unit 11:		
Estimation of creatinine by Jaffe's method	• Illustrate the quantity of plasma creatinine of unknown sample by Jaffe's method (P1, P2)	4
Unit 12:		
Estimation of uric acid by Caraway's method	• Demonstrate the quantity of serum uric acid of unknown sample by Caraway's method (P1, P2) • Interpret the significance of abnormal uric acid content with respect to renal function test (P1, P2)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	60	180
Revision		
Assessment	07	-

TOTAL	**67**	**180**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×	×		
Quiz						
Assignment/Presentation		×	×	×		
End Semester Examination						
Laboratory examination	×	×	×	×	×	×

Feedback Process	• End-Semester Feedback
Reference Material	• Tietz Textbook of Clinical Chemistry and Molecular Diagnostics :CA Burtis and DE Bruns, 6th Edition, Saunders Elsevier, 2008 • Laboratory Experiments in Biochemistry: LJ Daniel, Academic Press

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Environmental Science (Practical)**
Course Code: BBT 116	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: I Year, II Semester**
No of Credits: 2	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	This practical course helps to understand the fundamental knowledge and tools and practical applications of Environmental Sciences.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Estimation of pigment contents using spectrophotometer (P1, P2, P4, P6)
CO 2:	Sampling of different soil and analysis of pH (P2, P5, P7, P8)
CO 3:	Collection of soils and determination of water holding capacity (P2, P4, P5)
CO 4:	Estimation of toxicity of plant extracts and industrial water using seed germination test (P2, P3, P4, P7, P8)
CO 5:	Analysis of fungi/bacteria from soil, water and air samples (P5, P6, P2, P7)
CO 6:	Learning the extraction method and analysis of pigments by paper chromatography (P4, P5, P6, P7) and Demonstrate the ability to analyze water samples for coliform bacteria (P4, P5, P6, P7)

Mapping of COs to POs

Cos	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	x		x		x		x				x	x		
CO 2	×	x			x		x	x						x	
CO 3	×	x		x	x			x		x		x			x
CO 4	×	x	X	x			x	×					x		
CO 5	×	x		x	x			×	x					x	
CO 6	×			x	×	x	x	×			x		x		

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		

To determine chlorophyll content of the given plant material	• Estimation of pigment contents using spectrophotometer (P1, P2, P4, P6)	8
Unit 2:		
Quantitative analysis of soil pH	• Sampling of different soil and analysis of pH (P2, P5, P7, P8)	4
Unit 3:		
To determine water holding capacity of soil	• Collection of soils and determination of water holding capacity (P2, P4, P5)	8
Unit 4:		
Bioassay of toxic compounds by seed germination test	• Estimation of toxicity of plant extracts and industrial water using seed germination test (P2, P3, P4, P7, P8)	8
Unit 5:		
Isolation of bacteria/ fungi from environmental samples	• Analysis of fungi/bacteria from soil, water and air samples (P5, P6, P2, P7)	8
Unit 6:		
Qualitative analysis of plant pigments by paper chromatography	• Learning the extraction method and analysis of pigments by paper chromatography (P4, P5, P6, P7)	8
Unit 7:		
Determination of coliform count in different water samples	• Demonstrate the ability to analyze water samples for coliform bacteria (P4, P5, P6, P7)	8
Unit 8:		
Study on biodiversity in different ecosystems	• Learning and understanding of biodiversity in different ecosystems, i.e. lake and river (P1, P2, P3, P6)	8

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	60	180
Revision		
Assessment	07	-
TOTAL	**67**	**180**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	x	x	x		
Quiz	X	x	x	x	x	x
Assignment/Presentation	X		x			x

End Semester Examination						
Laboratory examination	X	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Lichtenthaler 1987. Chlorophylls and carotenoids: Pigments of photosynthetic biomembranes. Methods of Enzymology, 148, 350-382. • Berndt-Michael W. 2005. Determination of Chemical and Physical Soil Properties. In: Soil Biology, Volume 5, Manual for Soil Analysis, R. Margesin, F. Schinner (Eds.). Springer-Verlag Berlin Heidelberg. • Bioassay experiment, Catalog no. FBI1881, 2007, Flinn Scientific Inc. • Fawole M.O. and Oso B.A. 2001. Laboratory Manual of Microbiology. Rev. ed. Ibadan: Spectrum Books. • Boyer RF. 1990. Isolation and characterization of photosynthetic pigments. Biochemical Education 18(4), 201-204. • Wohlsen et al. 2006. Evaluation of the methods for enumerating coliform bacteria from water samples using precise reference standards. Letters in Microbiology 40(4), 350-356. • Ministry of Environment and Forests & Kalpavriksh. 2004. Nat. Biodiversity Strategy and Action Plan, India: Final Tech. Report of the UNDP/GEF Sponsored Project. MoEF, Govt. of India & Kalpavriksh, New Delhi/Pune (http://www.kalpavriksh.org/images/Biodiversity/Bio_NBSAP/Chapter4.pdf).

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Physics (Practical)**
Course Code: BBT 118	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 1	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	The objective of this course is to acquaint the students with basic physics experiments- to provide fundamental knowledge and applications of semiconductors in Zener diode and transistors, to provide basic understanding of electricity and magnetism, to provide basic knowledge and applications of optics through Newton's rings and Air wedge experiments
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Demonstrate and determine the surface tension of water by capillary rise method (P1, P4)
CO 2:	Demonstrate the effects of forward and reverse bias in Zener diodes (P1, P4)
CO 3:	Demonstrate and explain electricity and magnetism through RC time constant and Hall effect experiments (P4)
CO 4:	Demonstrate and explain thin film interference using Newton's rings and Air wedge experiments (P1, P4)
CO 5:	Demonstrate and explain transistor characteristics of a given transistor (P4)
CO 6:	Demosnstrate and find the ripple factors of a half wave and a full wave rectifiers (P1, P4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×							×							
CO 2	×				×			×							
CO 3	×							×							
CO 4	×				×			×							
CO 5					x										

CO 6	x				x										

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Transistor characteristics	• Demonstrate and draw the input characteristics of the given NPN transistor in common emitter configuration and determine knee voltage, input resistance and current gain (P1, P4)	4
Unit 2:		
Charging and discharging of a capacitor – RC time constant	• Demonstrate and determine the capacitance value of the given capacitors and RC time constant values using a DC charging and discharging circuits (P1, P4)	4
Unit 3:		
Zener diode characteristics	• Demonstrate and draw the V-I characteristic curve of a zener diode and determine breakdown voltage, forward knee voltage and zener resistance (P1, P4)	4
Unit 4:		
Newton's rings-'R' of a lens	• Demonstrate and determine the radius of curvature of the given plano-convex lens by Newton's rings exmeriment (P1, P4)	4
Unit 5:		
Surface tension by capillary rise method	• Demonstrate and determine the surface tension of water by capillary rise method (P1, P4)	4
Unit 6:		
LCR – circuit, Series and Parallel resonance	• Demonstrate the frequency response of series and parallel resonance circuits and determine the inductance of the given conductor and the quality factor of the circuit (P1, P4)	4
Unit 7:		
Rectifier filter circuit	• Demonstrate and find the ripple factors of a half wave and a full wave rectifiers (P1, P4)	2
Unit 8:		
Air wedge – diameter of a thin wire	• Demonstrate and determine the diameter of a given thin wire using air wedge method (P1, P4)	2
Unit 9:		
Hall effect	• Demonstrate and determine the density and velocity of charge carriers in the lattice (P1, P4)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	×	NA	×	NA	×	NA
End Semester Examination						
Laboratory examination	×	×	×	×	×	×

Feedback Process	• End-Semester Feedback
Reference Material	• Singh, Harnam, Hemne, PS. B.SC. Practcal Physics, Bangalore, S Chand, 2014. • P K, Jeethendra Kumar., Sharma, Prabhakar. Fundamental Physics Lab Experiments, Vol-1: Electricity Magnetism and Properties of Matter, Bangalore, Lab Experiments, 2018. • Melissinos, Drian., Napolitano, Jim. Experiments in Modern Physics, Cambridge, Academic Press, 2003. • Mandal, Soumitra Kumar., Basic Electronics, New Delhi, McGraw Hill Education, 2017. • Prakash, Indu., Krishna Ram., Jha, AK. Textbook of Practical Physics, New Delhi, Kitab Mahal, 2011.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Advanced Chemistry (Practical)**
Course Code: BBT 120	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: I Year, II Semester**
No of Credits: 1	**Prerequisites: Qualified I semester as per university guidelines**
Synopsis:	This practical course introduces and provides knowledge and technical skills in chemistry.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Demonstrate the determination of density and viscosity of given liquid using Ostwald viscometer (P1, P2) Find the composition of binary mixture using refractive index measurements(P1, P2)
CO 2:	Determine the strength of individual acid and acid mixture by the conductometric titration (P1, P2)
CO 3:	Find the dissociation constant of weak acid by conductivity measurement and pH meter (P1, P2)
CO 4:	Find the strength of Li_2SO_4 by the precipitation titration using conductivity measurements(P1, P2) Find the strength of given ferrous ammonium sulphate solution using redox titration (P1, P2)
CO 5:	To estimate the concentration of copper in the unknown sample by colorimetric estimation (P1, P2)
CO 6:	To study the kinetics of saponification of ethyl acetate by the help of conductivity measurement(P1, P2) To determine the purity of given sample by thin layer chromatography(P1, P2)
Mapping of COs to POs	

Cos	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	×													
CO 2	×	×													
CO 3	×	×													
CO 4	×	×													
CO 5	×	×													
CO 6	×	×													

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Determination of viscosity coefficient of a given liquid	• Define viscosity and understand viscosity as a fluid property. (P1) • Determination of density of the given liquid (P1, P2) • Determination of coefficient of viscosity (P1, P2)	6
Unit 2:		
Conductometric titration - Weak Acid vs strong base - Strong acid vs strong base - Acid mixture vs strong base - Precipitation titrations	• Understand the difference between equivalence and end point (P2) • To identify the equivalence point in an acid-base titration from the conductometric titration curve. (P1) • To compare the conductometric titrations vs analytical titrations (P2) • To determine the strength of given weak and strong acid (P2) • To determine the strength of ithium sulphate and potassium sulphate using precipitation titration (P1)	6
Unit 3:		
Percentage composition of binary solution – using refractometer	• Explain the working principle of refractometer (P1) • Determine the refractive index of series of solutions with different alcohol/water compositions (P2) • Determine the unknown concentration with the help of graph of refractive index versus composition(P1, P2)	2
Unit 4:		
Colorimetric method of analysis	• Understand the principle and applications of colorimetry (P1) • Determine the absorbance of series of solutions with different concentrations (P1, P2) • Determine the unknown concentration with the help of calibration curve (P1, P2)	2
Unit 5:		
Determination of dissociation constant of weak acid using pH meter	• To identify the half-equivalence point in an acid-base titration from the pH titration curve.(P1) • To describe what information the half-equivalence point in a weak acid/strong base (or strong acid/weak base) titration provides.(P1, P2) • To use a pH titration curve to determine the concentration of a solution containing an acid (base), the value of Ka (Kb) for an unknown weak acid (base)(P2)	4
• **Unit 6:**		

Determination of dissociation constant of weak acid using conductivity meter	• Calculate the degree of dissociation at different concentration (P1, P2) • Calculate the dissociation constant of weak acid (P1)	2
• **Unit 7:**		
Potentiometric titration-redox titration	• Determine the strength of ferrous ammonium sulphate solution (P1, P2)	2
• **Unit 8:**		
Determination of rate constant of a reaction – saponification of ethyl acetate by conductivity measurement.	• To list three reasons for studying chemical kinetics (P1) • Understand the concept of reaction rate and rate constant (P2) • To determine the second order rate constant for the saponification of ethyl acetate (P1, P2)	2
• **Unit 9:**		
Determination of rate constant of a reaction between KI and $K_{2S2}O_8$	• To determine the rate constant of the reaction(P1, P2)	2
• **Unit 10**		
Thin Layer Chromatography	• Explain the principle and applications of TLC (P1) • Demonstrate the separation of components in TLC (P1) • Identify the sample by comparing retention factor values (P2)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x				
Quiz						
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination						
Laboratory examination	x	x	x	x	x	x

Feedback Process	• End-Semester Feedback

Reference Material	• Yadav, JB. Advanced Practical Physical Chemistry, Goel Publishing House, 1981 • Findlay, A. Kitchenar, JA. Practical Physical Chemistry, (6th Edition) Longmans Green and Co., • Mann, FG. Saunders BC. Practical Organic Chemistry, New York Longmann

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Seminar/Journal Club**
Course Code: BBT 122	**Course Instructor: Class in-charge**
Academic Year: 2023 onwards	**Semester: I Year, II Semester**
No of Credits: 1	**Prerequisites: Qualified I Semester as per university guidelines**
Synopsis:	This course will include an allotment of an individual seminar topic related to the semester courses. This will enhance students' knowledge base and expose them to how to present information clearly and concisely. Students will also learn how to compile the literature database information.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react
CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks; students will also learn how to compile and interpret data

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×													
CO 4		×													
CO 5		×													
CO 6		×													

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual seminar topic related to the semester courses of the first semester	30-minute oral presentation for each student

Learning strategies, contact hours, and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	15	45
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	01	

TOTAL		**16**			**45**	
Assessment Methods:						
Formative:				**Summative:**		
Assignments/presentations				-		
Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA
Feedback Process	• End-Semester Feedback					
Reference Material	Reference Books and Journals articles related to the seminar topics					

Name of the Program:					**B.Sc. Biotechnology (Honours)**									
Course Title:					**Genetics (Theory)**									
Course Code: BBT 201					**Course Instructor: Course In-charge**									
Academic Year: 2023 onwards					**Semester: II Year, III Semester**									
No of Credits: 3					**Prerequisites: Qualified previous semesters as per regulations**									
Synopsis:	This course introduces basic concepts in genetics; chromosomes, patterns of inheritance, genetic variations and diseases.													
Course Outcomes (COs):	On successful completion of this course, students will be able to													
CO 1:	Explain Mendel's principles of segregation, and independent assortment (C1, C2, C3, C4)													
CO 2:	Understanding and interpretation of linkage, crossing and theories. (C1, C2, C4, C5).													
CO 3:	Outline and explain what gene interactions and non-nuclear inheritance are (C1, C2, C4, C5).													
CO 4:	Explain genetic anomalies caused by changes in chromosome number and structure (C1, C2, C3, C4													
CO 5:	Outline and classify mutations and mutagens and understand genetics of cancer (C1, C2, C3, C4)													
CO 6:	Explain the concepts of population genetics and importance of evolution (C1, C2, C3, C5)													
Mapping of COs to POs														
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×		x	x											
CO 2	×		x	x	x			x							
CO 3	×		x	x	x										
CO 4	×		x	×											
CO 5	×		x												
CO 6	×		x	x	x					×					
Course content and outcomes:														
Content	*Competencies*													*No of Hours*
Unit 1:														

Principles of Heredity	• History of genetics and its branches. Mendel's laws of inheritance; law of dominance, law of segregation, law of independent assortment, back cross and test cross, and multiple alleles. (C1, C 2, C 3, C 4)	7
Unit 2:		
Linkage & crossing over.	• Complete and incomplete linkage. Crossing over; factors, mechanisms, and theories. Frequency of crossing over, two-point and three-point test cross. (C 2, C4, C5)	7
Unit 3:		
Non-Mendelian inheritance	• Gene interactions; epistasis and non-epistasis, phenocopy, pleiotropy, penetrance and expressivity. polygenic inheritance, cytoplasmic inheritance (C1, C2, C3, C4)	10
Unit 4:		
Human Chromosomes	• Chromosome structure, types, chromosome abnormalities, syndromes and chromosomal theory of inheritance. (C1,C2,C3,C4)	8
Unit 5:		
Genes and mutations	• Genetic code, DNA mutations and mutagens (C1, C2, C3, C4)	3
Unit 6:		
Cancer genetics	• Hallmarks of cancer, oncogenes, tumour suppressors and familial cancers (C1, C2, C4)	3
Unit 7:		
Population genetics:	• Concepts of population genetics and factors affecting gene frequency. Importance of evolution and origin of species. (C1, C2, C3, C5)	3
Unit 8:		
Genetic counselling, testing and therapy	• Genetic testing and counseling, Gene therapy, eugenics, euthenics and euphenics (C1,C2,C3,C4,C5)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO6
Sessional Examination	X	X	X	X		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	X	X	X	X	X	X
End Semester Examination	X	X	X	X	X	X
Laboratory examination	NA	NA	NA	NA	NA	NA
Feedback Process	• End-Semester Feedback					
Reference Material	• Principles of Genetics by E.J. Gardner and D.P. Snusted. John Wiley & Sons, New York • The science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication. • Human Chromosomes by Miller, Orlando J., Therman, Eeva. Springer-Verlag New York Inc.; 4th ed. • Chromosome abnormalities and Genetic counselling. By R.J. McKinlay Gardner and David J. Amor. Oxford University Press, USA; 5 editions • An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C.Richard Lewontin, W.M-Gilbert, W.H. Freeman publication, • A Guide to Human Gene Therapy by Roland W. Herzog, Sergei Zolotukhin. World Scientific Publishing Company • Principles of Cancer Genetics by Bunz, & Fred. Springer-Verlag New York.					

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Molecular Biology (Theory)**
Course Code: BBT 203	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: II Year, III Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with general Molecular biology principles, to provide fundamental knowledge of biological macromolecules, including DNA, RNA, and proteins, and to understand the functions of the macromolecules.
Course Outcomes (COs):	On successful completion of the course, student will be able to
CO 1:	Know the structure and function of macromolecules such as DNA, RNA and Proteins (C1, C2).
CO 2:	Explain the process of genome replication and understand the role of various proteins in genome replications (C2, C4)
CO 3:	Learn various types of DNA damages and know associated DNA repair mechanisms (C2, C3)
CO 4:	Explain the synthesis, processing and functioning of RNAs (C2, C4)
CO 5:	Understand the regulation of gene expression and justify the importance of DNA binding proteins (C2, C2).
CO 6:	Discuss and illustrate the properties, types of vectors and analyse their applications (C2, C4). Discuss and explain the various genome regulation activity (C2, C4).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×			×											
CO 2	×			×											

CO 3	×		×		×										
CO 4	×			×											
CO 5	×		×												
CO 6	×														

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction and concepts in Molecular Biology	• Define and explain the major classes ,chemical structure, and functions of DNA, RNA, carbohydrate, proteins and lipids (C1, C2)	3
Unit 2:		
Genome replication	• Explain the Watson-crick scheme of DNA replication and variations in the DNA (C2, C3) • Understand the role of various proteins involved in DNA replication (C2) • Understand the process of DNA replication including initiation, elongation and termination of replication(C2, C4) • Explain the regulation of DNA replication (C2, C4)	4
Unit 3:		
Recombination at the Molecular level	• Define crossing over. Explain the process of crossing over (C1, C2) • Describe the process of homologous recombination (C2, C2) • Demonstrate three stranded and four stranded DNA helices and heteroduplexes (C2). • Understand the role of Rec A, Rec B-C proteins in recombination process (C2)	3
Unit 4:		
DNA damages and repair	• List various types of DNA damages (C1) • Discuss about various types of DNA lesions, oxidative damages, alkylation and bulky adducts (C2) • Explain different types DNA repair mechanisms with illustartions (C2, C4) • Illustrate and distinguish DNA repair mechanisms such as the base excision and nucleotide excision repair, SOS response in bacteria and alkylation repair, mismatch repair, single and double strand break repair pathways (C2)	4
Unit 5:		
Structure, synthesis, processing and function of RNAs:	• Define RNA synthesis. (C1) • Explain the basic principles of transcription-initiation, elongation and termination in prokaryotes and eukaryotes (C2) • UInderstand transcription in mitochondria and chloroplast (C2) • Explain the process of mRNA processing: capping, Intron splicing and polyadenylation. (C2) • Understand the synthesis and processing of non-coding RNA (C2) • Explain the transport of RNA, RNA editing, and RNA degradation (C2)	8
Unit 6:		
Regulation of gene expression	• Define heterochromatin, euchromatin and chromatin loops (C1) • Explain the structure of nucleosome. (C2,) • Elaborate on the process of chromatin packaging (C2)	6

	• Explain the histone modification (C2) • Define DNA methylation and explain the regulation of gene expression by DNA methylation (C1, C2) • Explain the regulation by miRNAs (C2)	
Unit 7:		
Structure and study of DNA binding proteins	• Describe the methods for studying DNA binding proteins (C2) • Explain DNA binding proteins and their interaction with DNA (C2) • Explain the structure and function of transcriptional activators (C2) • Explain eukaryotic repressors (C2)	**4**
Unit 8:		
Regulation of genome activity	• Discuss the transient changes in genome activity (C2) • Illustrate signal transmission by import of extracellular signalling compounds (C2) • Explain signal transmission mediated by cell-surface receptors (C2) • Explain the second messengers and genome regulation by feedback loops (C2) • Discuss the regulation of genome activity during development (C2)	5
Unit 9:		
Vectors for gene delivery	• Define vectors and list the properties of good vectors (C1) • Applications of various types of vectors (C3) • Distinguish between plasmids and cosmids (C4) • Explain the animal viruses, single stranded phages (C2) • Explain Ti plasmids, shuttle vectors, yeast vectors (C2) • Illustrate structural and functional organization of cauliflower mosaic virus (C2)	8

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x			

Quiz						
Assignment/Presentation	x	X	x	x		
End Semester Examination	x	X	x	x		
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Geoffrey Cooper, The Cell: A Molecular Approach, OUP USA (8th edition), 2019 • Karp, Gerald. Cell and Molecular Biology: Concepts and Experiments, John Wiley & Sons (7th edition), 2013 • Krebs JE, Goldstein ES, Kilpatrick ST. Lewin's Genes XII, Jones & Bartlett Learning, 2018 • David P. Clark, Nanette J. Pazdernik, Michelle R. McGehee. Molecular Biology 3rd Edition, Academic Cell, 2018 • Verma and Agarwal. Molecular Biology, S Chand and company, 2010 • Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Angelika Amon; Kelsey C. Martin. Molecular Cell Biology, Macmillan learning, 2016

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Microbiology (Theory)**
Course Code: BBT 205	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, III Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course provides knowledge on the general principles of microbiology, the role and function of microbes in ecosystem, their importance in diseases, agriculture, fermentation technology and in various other disciplines including recombinant DNA techniques.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	List and describe the major milestones and theories pertaining to the field of microbiology and explain and apply the different sterilisation methods (C1, C2, C3)
CO 2:	Name, describe and illustrate the various morphological forms and cell structure of different types of bacteria, fungi and viruses (C1, C2)
CO 3:	Explain and illustrate the gene transfer mechanisms in prokaryotes (C2, C3)
CO 4:	Distinguish the microbes based on their nutritional requirements (C2, C3, C4)
CO 5:	Explain and relate the interactions between microbial populations and role of microbial virulence factors in diseases (C2)
CO 6:	Demonstrate the use of microbes in fermentation products and in recombinant DNA technology (C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	x	x	x		X										
CO 2	x		x												
CO 3	x		x			x		x							
CO 4	x		x		X										
CO 5	x					x									
CO 6	x		x			x		x							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		

Historical background: Major milestones and disease terminologies in microbiology; Biogenesis and Pasteur's experiments disproving spontaneous generation; Prokaryotic and Eukaryotic microbial cells - endosymbiotic theory	List the major milestones, explain and outline the spontaneous generation theory and endosymbiotic theory (C1, C2)	3
Unit 2:		
Microbiological techniques: Microscopy, principles and types of microscopy; optical, TEM and SEM; the concept of asepsis, and sterilization methods	List and explain the different microscopic techniques; explain and apply the methods of sterilisation (C1, C2, C3)	3
Unit 3:		
Morphology: Morphological forms of bacteria; cocci, bacilli, spirilla & PPLOs; bacterial cell structure, appendages, serotypes, endosporulation; general structure and properties of fungi & viruses	Define and infer the morphological forms of bacteria, and properties of fungi and viruses (C1, C2)	7
Unit 4:		
Nutritional classification: Nutritional classification of microorganisms - Culture medias & bacterial growth curves	Compare and classify bacteria based on their nutritional requirements (C2, C3, C4)	3
Unit 5:		
Gene transfer mechanisms: Conjugation, Transduction, Transformation and Transposons in gene transfer in prokaryotes and their applications	What are the different gene transfer mechanisms in bacteria? Explain and illustrate the gene transfer mechanisms in bacteria and understand their applications (C1, C2, C3)	4
Unit 6:		
Variations in microbial population: Spontaneous and induced variation in microbial population	Define and describe the concept of spontaneous and induced variations (C1, C2)	3
Unit 7:		
Microbes in environment: Microbes in extreme environments - thermophiles and alkalophiles; interaction among microbial populations: Gause principle, symbiosis, antibiosis	Describe and provide examples for extremophiles and distinguish between different microbial interactions (C1, C2)	4
Unit 8:		
Microbial metabolism: Nature and diversity in microbial metabolism; Microbial virulence factors - antigenic nature, toxins	Explain the role of toxins in bacterial virulence and microbial metabolites (C2)	5
Unit 9:		
Parasitic diseases: Entamoeba histolytica; Plasmodium; Vaccines	Infer the role of microbes in diseases (C2)	4
Unit 10:		
Applications: Nitrogen fixing microbes in agriculture (2); microbial fermentation products and their uses	Describe and understand the role of microbes in agriculture and summarise the role of microbes in fermentation (C2, C3)	5
Unit 11:		
Genetic engineering of microorganisms: Recombinant DNA Techniques	Summarize and demonstrate the role of microbes in genetic engineering (C2, C3)	4

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×	×		
Quiz						
Assignment/Presentation	×	×	×	×	×	×
End Semester Examination	×	×	×	×	×	×
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Medical Microbiology – Mims CA, Playfair JHL, Roitt IM, Wakelin D, Williams R – 1998 - Mosby Publication • Clinical Virology – Richman DD, Whitley RJ, Hayden FG – 2002 - ASM Press • Topley & Wilson Microbiology and Microbial Infections – 2005 – Hodder Arnold • Hugo & Russell's Pharmaceutical Microbiology – Denyer SP, Hodges NA, Gorman SP, Gilmore BF – 2011 – Wiley Blackwell • Introduction to Microbiology - Ingraham JL, Ingraham CA – 1999 – S Chand & Co. • Prescott's Microbiology - Willey J, Sandman K, Wood D – 2019 – McGraw Hill

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biophysics (Theory)**
Course Code: BBT 207	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, III Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objective of this course is to introduce students to physics and chemistry principles/approaches useful to study biology- to provide basic knowledge on instrumentations and imaging tools of biological importance. To impart fundamental concepts of optics, lasers, optical fibers, nanotechnology, bioluminescence and superconductivity applications in biology
Course Outcomes (COs):	On successful completion of this course, students will be able to

CO 1:	Understand physical and chemical concepts used to solve biological problems (C2, C4)
CO 2:	Explain the usefulness of physics approaches, such as spectroscopy, microscopy, spectrometry, nanotechnology and imaging tools to study biology and applications (C2)
CO 3:	Compare different types of electromagnetic radiation and their applications and effects on biology and human health as well as different types of radiation detectors (C3)
CO 4:	Explain optical properties of biological matters, laser tissue interactions as well as their therapeutic applications, photodynamic therapy, bioluminescence (C2)
CO 5:	Explain the working principle of Magnetic Resonance Imaging, Optical Coherent Tomography and their applications (C2, C5)
CO 6:	Explain the working principle of fluorescence resonance energy transfer (FRET), Time Resolved Fluorescence spectroscopy (TRFS) and Surface plasmon resonance (SPR) and applications (C2, C5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×				×										
CO 4	×														
CO 5	×								×						
CO 6		x			x										

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction to X-ray diffraction and applications, calorimetry, mass spectrometry and applications and ultracentrifugation	• Explain basic working principle of X-ray diffractions and applications (C2, C5) • Illustrate the thermal behaviour of samples using calorimetry methods (C2) • Outline the principle and applications of ultracentrifugation (C2) • Explain mass spectrometry and applications (C2, C5)	7
Unit 2:		
Introduction to photodynamic therapy, mechanism of action of photodynamic action on cells to Viruses, Proteins and nucleic acids, photodynamic process in cell, bioluminescence	• Outline the concept of Photomorphogenesis, Bioluminescence, (C2) • Explain the photodynamic therapy and mechanism of photodynamic action on cells, viruses, proteins and nucleic acids (C2, C5)	5
Unit 3:		
Introduction to various spectroscopy techniques and applications	• Explain spectroscopic techniques including absorption (UV-Vis), Circular Dichroism, fluorescence, Raman and Dynamic Light Scattering (C2, C4) • Determine the chemical information using FTIR and NMR Spectroscopy (C5)	6
Unit 4:		

Introduction to fluorescence resonance energy transfer (FRET), Time Resolved Fluorescence spectroscopy (TRFS) and Surface plasmon resonance (SPR) and applications	• Explain the working principle of fluorescence resonance energy transfer (FRET) and its application (C2, C5) • Determine the lifetime of fluorophore using Time Resolved Fluorescence Spectroscopy (C5) • Illustrate surface plasmon resonance (SPR) and applications (C2)	6
Unit 5:		
Introduction to radiation detectors and microscopy	• Illustrate radiation detectors and applications (C2) • Explain the working principle of confocal microscope (C2, C5) • Identify optical microscope and electron microscope (C3)	7
Unit 6:		
Introduction to Quantum dots, optical coherent tomography (OCT), magnetic resonance imaging (MRI)	• Explain quantum dot imaging and application (C2, C5) • Explain the working principle of Magnetic Resonance Imaging, Optical Coherent Tomography and their applications (C2, C5)	5
Unit 7:		
Introduction to electromagnetic radiation including LASER and applications	• Explain various types of electromagnetic radiation, working principles of laser and types of lasers (C2, C5) • Explain the optical properties of tissues and laser-tissue interactions (C2, C5) • Explain photo-thermal, photochemical and photo ablation (C2, C5)	7
Unit 8:		
Introduction to Optical and Magnetic tweezers	• Explain the working principle of optical and magnetic tweezers and their applications (C2, C5)	2

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	×		×		×	
End Semester Examination	×	×	×	×	×	×
Laboratory examination	NA	NA	NA	NA	NA	NA
Feedback Process	• End-Semester Feedback					
Reference Material	• Tuszynski Jack A, Kurzynski Michal. Introduction to Molecular Biophysics, Florida, CRC Press, 2000. • Daune Michel. Molecular Biophysics: Structures in Motion, U.K., Oxford University Press, 1999. • Van Holde KE, Jonson WC. Principles of Biophysical Chemistry, U.S.A., Prentice Hall, 2005. • Banwell CN, McCash EM. Fundamentals of Molecular Spectroscopy, New Delhi, India Tata-McGraw-Hill Publishing Company Ltd. 2017. • Lakowicz JR. Principles of Fluorescence Spectroscopy (2nd Ed.), New York, Kluwer Academic/ Plenum Publishers, 1999. • Nadeau JL. Introduction to Experimental Biophysics: Biological Methods for Physical Scientists, Florida, CRC Press, 2011.					

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Genetics (Practical)**
Course Code: BBT 209	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, III Semester**
No of Credits: 2	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This practical course introduces and provides knowledge and practical skills in genetic analysis
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain and analyse how the transmission of genes occur within the family and distinguish between transmission of dominant and recessive phenotypes, (P1, P2)
CO 2:	Understanding the linkage of genes on a chromosome and crossing over (P1, P2, P3)
CO 3:	Demonstration and interpretation of inheritance of blood group and of sex determination (P1, P2, P3)
CO 4:	Explain lymphocyte culture, metaphase preparation and identify abnormalities. Calculation of chromosome length. (P1, P2, P3)
CO 5:	Examination of mitotic stages and polytene chromosomes (P1, P2, P3)
CO 6:	Knowledge of morphology of fruit fly (P1, P2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×		x	X											
CO 2	×														
CO 3	×			X	x										
CO 4	×					x									
CO 5	×														
CO 6	×														

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Pedigree analysis	Demonstration of Pedigrees and problems (P1, P2)	4
Unit 2:		
Mendel experiments	Demonstration of dominant and recessive phenotypes and their transmission in mono-/ di-/ tri- hybrids (P1, P2, P3)	4
Unit 3:		
Genetic problems	Demonstration of linkage of genes on a chromosome and cross-overs (P1, P2, P3)	4
Unit 4:		
Blood typing	Experiment on blood group and demonstration of biochemical and genetic background (P1, P2, P3)	4
Unit 5:		
Barr body	Experiment, demonstration, and interpretation of sex determination with buccal mucosa cells. (P1, P2, P3)	4
Unit 6:		
Metaphase preparation and Karyotyping	Lymphocyte culture, metaphase preparation, and screening (P1, P2, P3)	16
Unit 7:		
Micrometry	Experiment and demonstration of micrometry chromosomes and calculation (P1, P2, P3)	4
Unit 8:		
Mitosis	Squash preparation of mitotic stages with onion root tips (P1, P2, P3)	8
Unit 9:		
Polytene Chromosomes	Preparation and demonstration of polytene chromosome (P1, P2, P3)	4
Unit 10:		
Spotters (Drosophila Phenotypes)	Demonstration of various phenotypes of Drosophila melanogaster (P1, P2)	8

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	60	180
Revision		
Assessment	07	-
TOTAL	**67**	**180**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	X	X			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	X	X	X	X	X	X
End Semester Examination						
Laboratory examination	X	X	X	X	X	X

Feedback Process	• End-Semester Feedback
Reference Material	• Theory and problems of genetics, 4th edition by Elrod S.L. and Stansfield W.D. (Schaum's outlines) (2002), Tata McGraw-Hill, New Delhi. • Genetics – Classical to modern, 1st Edition. P.K. Gupta. 2013. • Chromosomal Aberrations: Basic and Applied aspects by Obe.G. and A.T. Natarajan (1990) Springer Verlag, Berlin.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Molecular Biology (Practical)**
Course Code: BBT 211	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: II Year, III Semester**
No of Credits: 2	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquire hands-on training in fundamentals of molecular biology principles; to provide fundamental knowledge on techniques involved in isolation and characterization of nucleic acids; and to understand the various methods of qualitative and quantitative analysis of nucleic acids derived from various biological samples.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the process of isolation and purification of genomic DNA and RNA from various biological sources (P1, P2, P3, P4)
CO 2:	Experiment and quantify DNA and RNA using qualitative and quantitative methods (P3, P4, P5)
CO 3:	Test for purity of isolated nucleic acids from various biological sources (P4, P5)
CO 4:	Demonstrate the process of bacterial transformation (P2, P3, P4)
CO 5:	Explain the method for isolation and purification of mitochondria (P2, P3).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×		×		×	×		×							
CO 2	×			×	×			×							
CO 3	×		×	×				×							
CO 4	×					×		×							
CO 5	×			×		×		×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Isolation and purification of *Escherichia coli* chromosomal DNA	• Explain the process of isolation and purification of Escherichia coli genomic DNA (P1, P2, P3, P4) • Experiment and quantify Escherichia coli genomic DNA using qualitative and quantitative methods (P3, P4, P5) • Test for purity of Escherichia coli genomic DNA (P4, P5)	4
Unit 2:		

Isolation of plasmid DNA	• Illustrate the method of isolation of plasmid DNA (P2) • Apply methodology for isolation of plasmid DNA (P3)	8
Unit 3:		
Agarose Gel Electrophoresis of plasmid DNA	• Explain the process of agarose gel electrophoresis (P2) • Analyse the outcome of agarose gel electrophoresis (P4)	8
Unit 4:		
Preparation of competent cells and bacterial transformation	• Demonstrate competent cell preparation (P2) • Make use of competent cells for bacterial transformation (P3) • Test for successful bacterial transformation (P4)	8
Unit 5:		
Restriction digestion of plasmid DNA	• Outline the process of restriction digestion of plasmid DNA and perform the experiment (P2, P3) • Analyse the outcome of restriction digestion of plasmid DNA (P4)	8
Unit 6:		
Isolation of genomic DNA from cell line	• Illustrate the method of isolation of genomic DNA (P2) • Apply methodology for isolation of genomic DNA (P3)	8
Unit 7:		
Determination of the concentration and purity of DNA by ultraviolet absorption spectroscopy	• Show the process of concentration and purity of DNA (P1, P2) • Apply and analyse the outcome of concentration and purity of DNA (P3, P4)	8
Unit 8:		
Isolation of total RNA and assessment of purity and integrity	• Demonstrate and plan the process of isolation of RNA and purity analysis (P2, P3) • Analyse and determine the outcome of isolation of RNA and purity of RNA (P4, P5)	8

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	60	180
Revision		
Assessment	07	-
TOTAL	**67**	**180**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination	x	x	x		
Quiz					
Assignment/Presentation	NA	NA	NA	NA	NA
End Semester Examination					
Laboratory examination	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Sue Carson Heather Miller Melissa Srougi D. Scott Witherow. Molecular Biology Techniques: A Classroom Laboratory Manual, 4th Edition, Academic Press, 2019 • Chaitanya K.V. Cell and Molecular Biology: A Lab Manual, PHI learning, 2013 • Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, 2010 • Joseph Sambrook and Michael R. Green. Molecular Cloning: A Laboratory Manual 4th Edition, Cold Spring Harbor Laboratory Press, 2014.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Microbiology (Practical)**
Course Code: BBT 213	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, III Semester**
No of Credits: 2	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This practical course introduces and provides knowledge and technical skills in handling microbes and understand their functional characteristics.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	List and illustrate the basic methods in microbiology (C1, P2)
CO 2:	Obtain pure cultures of microorganisms from mixed cultures (P2)
CO 3:	Identify bacteria based on their Gram staining and other staining characteristics (P2, P4)
CO 4:	List, explain and classify different bacteria based on biochemical tests (P2, P3, P4)
CO 5:	Demonstrate the ability to analyse and classify bacteria based on susceptibility to antibiotics (P2, P4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	x						x								
CO 2	x				x		x								
CO 3	x		X		x			x							
CO 4	x		X		x			x							
CO 5	x		X		x			x							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Basic methods in Microbiology: media preparation, sterilization, smear preparation and simple staining	• List and explain the basic methods in microbiology (C1, P2)	8
Unit 2:		

Gram staining	• Identify bacteria based on their Gram staining characteristics (P2, P4)	8
Unit 3:		
Inoculation techniques: aseptic culture techniques, spread-plate and streak-plate, pour plate technique	• Obtain pure cultures of microorganisms from mixed cultures (P2)	8
Unit 4:		
Antimicrobial susceptibility test	• Demonstrate the ability to analyse and classify bacteria based on susceptibility to antibiotics (P2, P4)	8
Unit 5:		
Metabolic characterization	• List, explain and characterize bacteria based on their biochemical profiles (C1, P2, P3, P4)	12
Unit 6:		
Bacterial motility	• Perform and display the bacterial motility test (P2)	8
Unit 7:		
Determination of bacterial numbers	• Explain methods to determine bacterial numbers and measure bacterial counts based on turbidity (P2, P3, P4)	8

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	60	180
Revision		
Assessment	07	-
TOTAL	**67**	**180**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination	×	×	×	×	
Quiz					
Assignment/Presentation					
End Semester Examination					
Laboratory examination	×	×	×	×	×

Feedback Process	• End-Semester Feedback
Reference Material	• Harley JP, Prescott LM, Laboratory Exercises in Microbiology, McGraw Hill, 2002.

	• Mukesh Kumar, Practical Manual for Undergraduates Microbiology, Jain Brothers India, 2010.

Name of the Program:							**B.Sc. Biotechnology (Honours)**								
Course Title:							**Biophysics (Practical)**								
Course Code: BBT 215							**Course Instructor: Course In-charge**								
Academic Year: 2023 onwards							**Semester: II Year, III Semester**								
No of Credits: 1							**Prerequisites Qualified previous semesters as per regulations**								
Synopsis:	The objectives of this course are to acquaint the students with basic biophysics experiments - to provide hands on training of various optical spectroscopy techniques, to provide basic knowledge on radiation and their detections, to provide basic information on differential scanning calorimetry, diffraction grating and their applications, to provide information on Polarimetery and applications														
Course Outcomes (COs):	On successful completion of this course, students will be able to														
CO 1:	Determine the specific rotation of sucrose solution using a half shade polarimeter (P1, P4)														
CO 2:	Explain the numerical aperture of an optical fiber (P1, P4)														
CO 3:	Explain diffraction grating as well as absorption (V-vis), fluorescence and Raman spectroscopy signals (P4)														
CO 4:	Explain the principles of GM counter, differential scanning calorimetry (P1, P4)														
CO 5:	Determine the wavelength of the lines in the mercury spectrum by minimum deviation method (P1,P4)														
CO 6:	Determine the forbidden energy gap of a semiconductor (P1, P4)														
Mapping of COs to POs															
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×				×			×							
CO 2	×			×				×							
CO 3	×				×	×		×							
CO 4	×						×	×							
CO 5	x			x											
CO 6	x			x											

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Fluorescence spectroscopy	• To demonstrate the fluorescence spectra of biomolecules and assignment of spectral bands (P1, P4)	2
Unit 2:		
Raman spectroscopy	• To demonstrate the Raman spectra of acetone and ethanol and assignment of spectral bands (P1, P4)	2
Unit 3:		
UV-vis spectroscopy	• To demonstrate and verify Beer Lambert's law using potassium permanganate solution and to find concentration of the unknown solution using the calibration curve (P1, P4)	4
Unit 4:		

Polarimeter	• To determine the specific rotation of sucrose solution using a polarimeter and hence to find the unknown concentration of sucrose solution (P1, P4)	4
Unit 5:		
Numerical aperture of an optical fiber	• Determination of numerical aperture of an optical fiber (P1, P4)	4
Unit 6:		
Energy gap of a semiconductor	• To determine the forbidden energy gap of a semiconductor (P1, P4)	4
Unit 7:		
Diffraction grating	• To determine the wavelength of the lines in the mercury spectrum by minimum deviation method (P1,P4)	4
Unit 8:		
GM counter	• To demonstrate and draw the characteristics of a GM tube and hence calculate (a) Threshold voltage (b) Plateau region (c) Operating voltage (d) Plateau slope of the GM tube (P1, P2)	4
Unit 9:		
Differential scanning calorimetry	• To demonstrate the thermal properties of a sample using differential scanning calorimetry (P1, P2)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	×	NA	×	NA	×	NA
End Semester Examination						
Laboratory examination	×	×	×	×	×	×

Feedback Process	• End-Semester Feedback

Reference Material	• Lakowicz JR. Principles of Fluorescence Spectroscopy (2nd Ed.), New York, Kluwer Academic/ Plenum Publishers, 1999. • Dennis H. Goldstein. Polarized Light, USA, CRC Press, 2011. • Ferraro John. Introductory Raman Spectroscopy, USA, Academic Press, 2002 • Jay L. Nadeau. Introduction to Experimental Biophysics: Biological Methods for Physical Scientists (Foundations of Biochemistry and Biophysics), Florida, USA, CRC Press; 1 Edition, 2011. • Van Holde KE, Jonson WC. Principles of Biophysical Chemistry, U.S.A., Prentice Hall, 2005. • Seeger Karlheinz. Semiconductor Physics: An Introduction, USA, Sprnger, 2004.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title	**Seminar/Journal Club**
Course Code: BBT 217	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, III Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course will include an allotment of an individual seminar topic related to the semester courses. This will enhance students' knowledge base and expose them to how to present information clearly and concisely. Students will also learn how to compile the literature database information.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react
CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks, and learn how to compile and interpret data.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×													
CO 4		×													
CO 5		×													
CO 6		×													

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual seminar topic related to the semester courses	30 minutes oral presentation for each student

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	15	45
Small Group Discussion (SGD)		
Self-directed learning (SDL)		

Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	01	-
TOTAL	**16**	**45**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	X	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the seminar topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Biostatistics (Theory)**
Course Code: BBT 202	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: II Year, IV Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	To provide necessary foundation in probability and probability distributions so as to apply it to model and analyse biological phenomenon
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	DESCRIBE different approaches to probability. (C6)
CO 2:	SUMMARIZE elementary theorems of probability. (C5)
CO 3:	DISTINGUISH between discrete and continuous random variables, and IDENTIFY when and how to use their corresponding distributions. (C4, C4)
CO 4:	RELATE marginal, conditional and joint distribution functions. (C6)
CO 5:	EVALUATE expectations of linear combination of random variables. (C6)
CO 6:	APPLY hypothesis testing (C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×														
CO 4	×														
CO 5	×														
CO 6				×											

Course content and outcomes:

Content	*Competencies*	*No of Hours*

Unit 1:		
Introduction and basic concepts	• EXPLAIN how probability and probability distributions are applied to model and analyse biological phenomenon. (C6) • DISTINGUISH between all four levels of measurements (C4) • EXPLAIN different types of variables (C6)	2
Unit 2:		
Sampling	• DEFINE population, sample (C1) • STATE the advantages and disadvantages between sample studies and census. (C1) • EXPLAIN different types of samples (C2) • DESCRIBE probability sampling and non-probability sampling (C1) • EXPLAIN simple random sampling, stratified random sampling, systematic sampling, cluster sampling, multistage sampling, multiphase sampling (C2) • WRITE merits and demerits of different types of method of sampling (C3) • EXPLAIN sampling error (C2)	5
Unit 3:		
Descriptive statistics	• DISTINGUISH between all four levels of measurements (C4) • EXPLAIN different types of variables (C6) • DIFFERENTIATE between frequency tabulations and frequency curves (C4) • EXPLAIN different measures of central tendency (C2) • COMPUTE different measures of central tendency (C3) • WRITE demerits and merits of Arithmetic mean, Geometric mean, Harmonic mean, Median and Mode (C3) • EXPLAIN different measures of dispersion (C2) • COMPUTE different measures of dispersion (C3) • WRITE merits and demerits of Range, Mean deviation, Variance, Standard deviation, Coefficient of variation, Quartile deviation and inter quartile range (C3) • CREATE presentation of data as tabular, graphs and diagrams (C5)	6
Unit 4:		
Probability and probability distributions	• State basic theorems & properties of probability (C1) • Solve problems that involve the application of basic theorems and properties of probability (C6) • Define and illustrate conditional probability (C4) • Illustrate total probability rule & Bayes' rule (C4) • Apply the definition of conditional independence to determine whether two events are conditionally independent (C4) • Illustrate the difference between probability computation for discrete & continuous random variables (C4) • Describe random variables (C1) • List properties of probability functions (C2) • Recall the definitions of marginal probabilities, conditional probabilities from joint distribution (C1) • Verify independence of random variables (C3) • Evaluate expectation a random variable (C6)	8

	• Recall the definitions of a Bernoulli trial, Binomial experiment and properties of a Poisson process (C1) • Recognize cases where the following distributions could be an applied model: Bernoulli, Binomial and Poisson (C2) • Identify parameters of: Bernoulli, Binomial and Poisson (C2) • Calculate probabilities, the mean and variance of the following random variables: Bernoulli, Binomial and Poisson (C4) • Approximate Binomial probabilities using a Poisson distribution where appropriate (C6) • Demonstrate an understanding of the basic concepts of continuous random variables of common continuous distributions (C3) • Identify the parameters, calculate probabilities, mean and variance of: Bernoulli, Binomial, Poisson and Normal (C4) • Recall the properties of a Normal distribution, and those of the standard Normal distribution (C1) • Obtain probabilities related to Normal random variables using the standard Normal table (C4) • Approximate Binomial probabilities using a Normal distribution wherever appropriate (C5)	
Unit 5:		
Sampling distribution and confidence intervals	• SUMMARIZE the Central Limit Theorem (C2) • DISTINGUISH between a parameter and a statistic (C2) • DEFINE sampling distribution (C1) • DISTINGUISH between population distribution and sampling distribution (C2) • DESCRIBE the relationship between sample size and the variability of an estimator (C1) • DESCRIBE the distribution of the sample mean (C1) • DESCRIBE the distribution of the difference between two sample means (C1) • DESCRIBE the distribution of the sample proportion (C1) • DESCRIBE the distribution of the difference between two sample proportions (C1) • ESTIMATE unknown population parameter using a point estimator for the parameter (C2) • CONSTRUCT and INTERPRET a confidence interval for a population proportion, mean, difference between two sample proportions, difference between two sample means (C5, C3) • DESCRIBE how the margin of error of a confidence interval changes with the sample size and the level of confidence C (C2) • DETERMINE sample statistics from a confidence interval (C2)	8
Unit 6:		
Tests of significance	• STATE correct hypotheses for significance test about a population proportion, mean, difference between two sample proportions, difference between two sample means (C1) • INTERPRET P-values in context. (C3) • INTERPRET a Type I error and a Type II error in context, and give the consequences of each. (C3)	8

	• DESCRIBE the relationship between the significance level of a test, P(Type II error), and power. (C2) • DISTINGUISH between a parametric and nonparametric tests of significance (C2) • DESCRIBE the characteristics of the sampling distribution of sample proportion, mean, difference between two sample proportions, difference between two sample means (C2) • CALCULATE probabilities using the sampling distribution of the sample proportion, mean, difference between two sample proportions, difference between two sample means (C3) • ILLUSTRATE whether the conditions for performing inference are met (C3) • USE z statistic for one sample mean or proportion when population standard deviation is known (C3) • USE t statistic for one sample mean or proportion when population standard deviation is unknown (C3) • COMPUTE a significance test for one sample mean or proportion (C3) • USE z statistic to compare two means or two proportion when population standard deviation is known (C3) • USE t statistic to compare two means or two proportion when population standard deviation is unknown (C3) • COMPUTE a significance test to compare two means or two proportion (C3) • ANALYZE paired data by first taking the difference within each pair to produce a single sample and USE one-sample t procedures (C4) • EXPLAIN F-test (C2) • USE of Analysis of Variance (ANOVA) (C3) • COMPUTE statistical test for one-way ANOVA (C3)	
Unit 7:		
Correlation and regression	• CALCULATE and INTERPRET the correlation between two variables (C4, C3) • ILLUSTRATE whether the correlation is significant. (C3) • CALCULATE the simple linear regression equation for a set of data (C4) • STATE basic assumptions behind regression analysis (C1) • ILLUSTRATE whether a regression model is significant (C3) • RECOGNIZE regression analysis applications for purposes of description and prediction (C2)	4
Unit 8:		
Sample size determination	• ILLUSTRATE the sample size required to obtain a level C confidence interval for a population proportion with a specified margin of error (C3) • DESCRIBE how the margin of error of a confidence interval changes with the sample size and the level of confidence C (C3) • ILLUSTRATE the sample size required to obtain a level C confidence interval for a population mean with a specified margin of error (C3) • DESCRIBE how the margin of error of a confidence interval changes with the sample size and the level of confidence C (C3)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135

Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x	x		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	NA	NA	NA	NA	NA	NA
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Ross SM. Introduction to probability models. Academic press; 2014. • Johnson NL, Kemp AW, Kotz S. Univariate discrete distributions. John Wiley & Sons; 2005. • Johnson NL, Kotz S, Balakrishnan N. Continuous univariate distributions. John Wiley & Sons; 1991. • Rosner B. Fundamentals of biostatistics. Duxbury Thomson Learning; 2000. • Bhat BR. Modern probability theory. New Age International; 2007. • Daniel WW. Biostatistics: a foundation for analysis in the health sciences. John Wiley & Sons; 2008.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Pharmacology and Pharmacogenomics (Theory)**
Course Code: BBT 204	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: II Year, IV Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with the general, Principles of pharmacology and pharmacogenomics. To provide fundamental knowledge of the drug, their mechanisms, actions, and side effects, to understand the role of regulatory bodies in controlling the drug development. To understand how the molecular biology techniques, help in the development of new drugs and personalization of it.
Course Outcomes (COs):	On successful completion of the course, students will be able to
CO 1:	Learn the important discoveries and know about the scientist in the field of pharmacology (C1)

CO 2:	Understand the what happens to drug in the body when the drug is taken and what body does to drug and how various parameters affect the influence (C2, C3) Know and explain the pharmacological models used in the hypertension, diabetes and Alzheimer's disease and understand their application in drug discovery (C2, C3)
CO 3:	Explain the mode of actions of various classes of chemotherapy drugs, types of cancer chemotherapies, and antidotes used for heavy metal poisoning (C2, C3)
CO 4:	Explain the role of biotechnology in the development of pharma filed Discuss various techniques used to in pharmacology studies and its application (C1, C2).
CO 5:	Describe the regulatory issues associated with pharmacology (C1, C2)
CO 6:	Understand the pharmacogenomics, Explain the how the genetic makeup influences the effect of drug, and understand the mechanisms of it in neuro-psychiatric disorders, Cardiac diseases, Pulmonary diseases, Cancer pharmacogenomics (C2, C3).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×		×												
CO 3	×		×												
CO 4	×					X									
CO 5	×														
CO 6	×		×		×										

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
General Pharmacology	Understand the historical development of pharmacology. Nobel laureates and their discoveries in pharmacology (C1)	3
Unit 2:		
Pharmacokinetics and Pharmacodynamics	Describe the - routes of drug administration. Principles, practices and mechanisms of drug absorption, distribution, biotransformation on/metabolism, and excretion of drugs. General mechanism of drug action, factors modifying drug action, Drug toxicity and consequences of adverse drug reaction (C2, C3). Pharmacological screening models for therapeutic areas such as hypertension, diabetes Alzheimer's disease and alternatives to animal experimentations, Organs-on-chips (C2, C3).	9
Unit 3:		
Chemotherapy and antidotes in poisoning	Describe various categories of anticancer drugs. General considerations, antibiotics – anti-TB, anti-malarial, anti-helminthic, anti-viral drugs. Drugs used in heavy metal poisoning (C2, C3)	5
Unit 4:		
Biotechnology of pharmaceutical sciences	Explain drug discovery, vaccines, immune-stimulants and suppressants, gene therapy, monoclonal antibodies, Biopharmaceutical drugs (C2, C3)	4
Unit 5:		
Regulatory issues	Describe the drugs and Cosmetics Act, CDSCO guidelines, USFDA guidelines, Preclinical drug evaluation, Ethical considerations in	4

	utilizing animals and human subjects for the drug discovery process (C2, C3)	
Unit 6:		
Pharmacogenetics and pharmacogenomics	Understand the history and early evidence and examples. Describe the concept of personalized medicine. Pre- and post-genomic pharmacogenetics, current status (C2, C3)	4
Unit 7:		
Categories of pharmacogenomic knowledge	Explain the drug metabolizer, drug target and drug transporter encoding genes showing variation affecting drug response. Cellular and functional assays (C2, C3)	6
Unit 8:		
Pharmacogenomics of major classes of diseases	Describe the pharmacogenomics of major disease like Neuro-psychiatric disorders, Cardiac diseases, Pulmonary diseases, and Cancer. Examples of pharmacogenes relevant to the major diseases. Pharmacogenomics of populations and principles of genetic association studies (C2, C3)	5
Unit 9:		
Tools and techniques in pharmacogenomics	Explain the tools, and techniques, and the diagnostic testing for pharmacogenomic variations. Polymerase chain reaction, microarrays, DNA sequencing and next-generation sequencing technologies and their applications in Pharmacogenomics. Genome-wide association studies (GWAS). Pharmacogenomics in drug discovery and trials. Pharmacogenomic databases (C3)	5

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x			
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x

Laboratory examination	NA	NA	NA	NA	NA	NA
Feedback Process	• End-Semester Feedback					
Reference Material	• Essentials of Medical Pharmacology (7th Ed.) – Tripathi KD, Jaypee Brothers Medical Publishers (P) Ltd, 2013 • Basic and Clinical Pharmacology (11th Ed), Katzung B.G. et al., Tata McGraw - Hill Education, 2009. • Drug discovery and evaluation: pharmacological assays. Vogel, Hans Gerhard (Ed.). Springer, 2008. • Basic and Clinical Pharmac Principles of Pharmacogenetics and Pharmacogenomics. Eds. Russ B. Altman, David Flockhart, David B. Goldstein. Cambridge University Press, 2012. • FDA Regulatory Affairs (3rd Ed), Pisano, D.J. and Mantus, D., CRC Press, 2014. • New Drugs and Clinical Trials Rules, 2019.Central Drugs Standard Control Organization. Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India. URL: https://cdscoonline.gov.in/CDSCO/Downloads • Pharmacogenomics- Challenges and Opportunities in Therapeutic Implementation (2nd ed). Eds. Yui-Wing Francis Lam Stuart Scott, Academic Press, 2018. • The pharmacological basis of therapeutics. (11th Ed), Goodman Gilman, A., Rall, T.W., Nies, A.I.S. and Taylor, P. McGraw Hill, Pergamon Press, 2006. • T E Klein, R B Altman (2004) PharmGKB: the pharmacogenetics and pharmacogenomics knowledge base. Pharmacogenomics J.4(1):1					

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Plant Biotechnology (Theory)**
Course Code: BBT 206	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: II Year, IV Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This module helps to understand the knowledge obtained in basic courses of plant biotechnology, to provide fundamental knowledge of plant cell, tissue and organ culture & its translational applications, and to understand the fundamental of tools and technology for product scale-up & crop improvement.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Learning the history and aim and target, Plant cell, tissue and organ culture and their importance in crop improvement and sustainability (C1, C2)
CO 2:	Explain the methods for culture, protoplast fusion and cell hybridisation (C2, C4)
CO 3:	Learning methods to develop disease free plants (C2, C4)
CO 4:	Explain the fundamentals of somaclonal and gametoclonal variations and their impact on trait improvement of plants (C2, C5) and Discuss and illustrate the plant metabolite and product scale up strategies (C2, C4, C6)
CO 5:	Knowledge on gene transfer techniques and development of transgenic plants, available transgenic crops in India and word, gene cloning, RFLP, transposons and insertional mutagenesis (C1, C2) and Understanding of nitrogen fixation, features of *nif* genes, gene transfer for herbicide and stress tolerance (C2, C3)
CO 6:	Learning different types of bioinsecticides and biofertilizers and Knowledge on RET species, germplasm collection, preparation and conservation

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	×													

CO 2	×	×													
CO 3	×	×													
CO 4	×	×		×											
CO 5	×	×													
CO 6	×	×								×					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Historical overview of the genesis of Plant Biotechnology	• Define and explain plant tissue culture concept, important milestones (C1, C2) • Understanding the types of plant tissue culture and its impact on agro-economic productivity (C2, C4)	4
Unit 2:		
Tissue culture and genetic Variability in Plant Stocks	• Define the fundamentals of clonal variations (C1, C2, C5) • Explain the process of natural and induced trait variations in plants (C2, C5, C6) • Demonstrate the potential applications of Plant breeding (C2). • Outline the mechanism of somaclonal and gametoclonal variations (C2)	4
Unit 3:		
Production of disease free plants: Shoot – tip – cultures, shoot – tip – grafting, viricidal compounds.	• Learn the suitable methods to culture different explants and production of disease free plants (C1, C2, C5)	4
Unit 4:		
Protoplast isolation and culture	• Provide effective methods for protoplast from plant tissues (C2) • Explain cell hybridization techniques and their effective protocols (C2, C5) • Illustrate screening methods for hybridized cells (C2) • Explain the methods for culture, maintenance and regeneration of cybrids from plant cells (C2, C5) • Identification of eite clones from hybrids and cybrids (C2, C5)	4
Unit 5:		
Plant cell culture and Industrial scale up	• List the basic set up for initialising plant cell cultures (C1) • Discuss the role of plant growth regulators (both natural and synthetic) (C6) • Explain different industrially valuable compounds from plant tissue culture and bioreactors (C2, C5) • Illustrate and distinguish conventional and modern plant breeding tools (C2) • Explain the fundamentals of gene transfer in plants (C6) • Understanding the role of exogenous and endogenous influencers of plant cell cultures (C6)	8
Unit 6:		
Genetic Engineering:	• Knowledge on gene transfer methods – Ti plasmid and suitable vectors (C1, C2) • Production of transgenic plants	8

	• Currently available GM crops in India and word (C2, C4) • Characterization of GM plants (C6) • Understanding RFLP, transposons and insertional mutagenesis (C1, C2)	
Unit 7:		
Biology of Nitrogen Fixation in Plants	• Understanding the status of Genetically modified Crops -India and Global Scenario (C6) • Define Nitrogen cycle and types of Nitrogen fixation (C1,C2) • Illustrate the mechanism of nitrogen fixation in leguminous crops (C2) • Demonstrate the methods for Nif gene, herbicide resistance and stress tolerant genes in plants (C2)	5
Unit 8:		
Advances in bioinsecticides and biofertilizers	• Define insecticides and fertilizers (C1) • Explain the toxic effects of synthetic pesticides and fertilizers (C2,C5) • Illustrate the mechanism iof biofertilizers and bioinsecticides (C2) • Explain the potential applications of bioinsecticides - an ecological perspective (C2,C5) • Discuss the advantages and disadvantages of biological methods for combating pests and pathogens of plants (C1, C2, C5)	4
Unit 9:		
Preservation of rare plant species, germplasm collection and conservation	• Illustrate the methods of Germplasm conservation (C2) • Explain the methods of collection, herbarium preparations and in vivo and in vitro storage (C2,C5) • Explain the strategies followed by IUCN and Botanical Survey of India for conservation (C2,C5) • Explain the guidelines of IUCN and BSI for preservation of indigenous RET species (C2,C5)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination

Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	X	X		
Quiz	x	x	X	x	x	x
Assignment/Presentation	x	x	X	X	x	x
End Semester Examination	x	x	X	X	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Biological Science (3rdEd) - Taylor DJ, Green NPO, Stout GW. - 2002 - Cambridge University Press • Plant Cell Culture: A practical approach - Dixon RA, Gonzales - IRL Press. • Plant Tissue Culture Manual – Lindsey K – 1991- Kluwer Academic Publ, Dordrecht • Plant Tissue Culture – Concepts and laboratory exercise – Trigiano & Gray, 1999, 2nd Ed. CRC press. • Transgenic plants Vol.1 & 2:- Kung S-D, Wu R – 1993 - Academic Press, San Diego • Plant Tissue Culture: Applications and limitations – Bhojwani SS – 1990 - Elsevier, Amsterdam. • Micropropogation – Debergh PC, Zimmerman RH – 1990 - Kluwer Academic Publishers, Dordrecht. • Plant Molecular Biology - Grierson D, Covey SN - Blackie, London. • Plant Molecular Biology – Goldberg RB – 1983 - Allan R Liss Inc. New York.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Bioinformatics (Theory)**
Course Code: BBT 208	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course will provide fundamental knowledge of various bioinformatics tools and databases from major consortiums such as NCBI and introduce students to the computational methods for solving biological problems.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	List of different types of data found at the NCBI, and other resources and explain how to locate and extract data from key bioinformatics databases and resources (C1, C2)
CO 2:	List the concepts and applications of sequence similarity searching and provide an outline of the different approaches to sequence alignment (C1, C2, C3)
CO 3:	Apply the concepts of phylogenetics to infer phylogeny from sequences. (C2, C3)
CO 4:	Infer the different levels and organisation of protein structures (C1, C2)
CO 5:	Identify and apply numerous bioinformatics software for the purpose of primer design, restriction mapping, computational gene prediction and motif finding (C1, C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	X														
CO 2	X		X			X				X					

CO 3	X		X			X				X					
CO 4	X									X					
CO 5	X		X			X				X					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction and biological databases: Scope, goals and application of bioinformatics, classification of biological databases, locate and extract information with a focus on NCBI databases.	• List of different types of data found at the NCBI, and other resources and explain how to locate and extract data from key bioinformatics databases and resources (C1, C2)	11
Unit 2:		
Sequence alignment: Concepts of homology, scoring matrices (PAM and BLOSUM), similarity searches including pairwise and multiple sequence alignment.	• List the concepts and applications of sequence similarity searching and provide an outline of the different approaches to sequence alignment (C1, C2, C3)	9
Unit 3:		
Molecular phylogeny: Concepts of phylogeny, types of trees, tree construction methods, tree validation techniques.	• Apply the concepts of phylogenetics to infer phylogeny from sequences. (C2, C3)	5
Unit 4:		
Structural bioinformatics: Protein databases, protein structure basics, primary, secondary and tertiary structures, protein structure visualization, secondary structure prediction, tertiary structure prediction.	• Infer the different levels and organisation of protein structures (C1, C2)	10
Unit 5:		
Computational biology: Restriction mapping, primer designing, computational gene prediction.	• Identify and apply numerous bioinformatics software for the purpose of primer design, restriction mapping, computational gene prediction and motif finding (C1, C2, C3)	10

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**

Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination	X	x	x	x	
Quiz	NA	NA	NA	NA	NA
Assignment/Presentation	X	x	x	x	x
End Semester Examination	X	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Bioinformatics Methods and Protocols. 2003. Stephen Misener and Stephen A Krawetz, Humana Press, Totowa, New Jersy • Essential Bioinformatics. Jin Xiong. Cambridge University Press. • A user's guide to the human genome. 2002. Tyra G. Wolfsberg, Kris A. Wetterstrand, Mark S. Guyer, Francis S. Collins & Andreas D. Baxevanis, Nature Genet., volume 32: 1-79. • Fundamental concepts of Bioinformatics. 2003. Dan E Krane and Michael L Raymer, DorlingKindersley (India) Pvt. Ltd. • Bioinformatics: From Genomes to Drugs, Volume I. 2001. Thomas Lengauer (Ed.). John Wiley & Sons. • Bioinformatics: Sequence and Genome Analysis. 2001. David W. Mount, Cold Spring Harbor Laboratory Press. • Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 1998. Andreas D. Baxevanis, B.F. Francis Ouellette, John Wiley & Sons. • Discovering Genomics, Proteomics and Bioinformatics (2nd edition). 2006. A. Malcolm Campbell and Laurie J. Heyer, Cold Spring Harbor Laboratory Press and Benjamin Cummings.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Immunology (Theory)**
Course Code: BBT 210	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course provides knowledge on the basic principles of immunology, the role and function of immune cells and different types of immunity, the generation of immunity, their importance in various conditions such as autoimmune disorders, immunodeficiency syndromes, and other diseases, various assays related to antigen-antibody reactions synthesis and in various other disciplines including production of monoclonal antibody techniques.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Learn the major milestones and basic concepts in the field of immunology (C1, C2)
CO 2:	An illustrative description of immune cells and lymphoid organs of the immune system. (C1, C2, C3)
CO 3:	Understanding inflammatory mediators, acute and chronic inflammation including leukocyte recruitment, and trans-endothelial migration (C1, C2, C4)
CO 4:	Compare and contrast antigens, haptens and superantigens. Understanding antigen-antibody reactions and techniques (C1, C2, C3)

CO 5:	Understanding antibody structure, classes, functions, and diversity. Hybridoma technology (C1, C2, C3, C5).
CO 6:	Discuss MHC molecules; structure and function. Antigen processing and presentation. Types of grafts, graft rejections (C1, C2, C6).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	x	x	x												
CO 2	x		x		X										
CO 3	x		x												
CO 4	x		x			x		x							
CO 5	x		x		X										
CO 6	x					x									

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Historical background & Basic concepts	Milestones of immunology. General introduction to the innate and adaptive immune system (C1, C2)	2
Unit 2:		
Immune cells & Lymphoid organs	Cells and organs of the immune system -Thymus, bone marrow, spleen, lymph node. T and B lymphocytes. Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors (C1, C2, C4, C6)	8
Unit 3:		
Inflammation	Acute and chronic inflammation, cell and plasma- derived mediators, Leukocyte recruitment, trans-endothelial migration (C1, C2, C3)	4
Unit 4:		
Cytokines & Complement	Cytokines, Properties, functions and classification of cytokine families. Interleukins, Interferons, Complement components and biological consequences of complement activation. (C1, C2, C4, C6).	4
Unit 5:		
Immunoglobulins	Structure of immunoglobulins, Immunoglobulin classes, and biological activities. Isotypes, Allotypes, Idiotypes. Immunoglobulin genes and antibody diversity, Class switching, Humoral and cell-mediated immune responses (C1, C2, C3, C6).	8
Unit 6:		
Antibody Engineering	Hybridoma technology - production of monoclonal antibodies and their applications. Antibody diversity and class switching (C1, C2, C3)	4
Unit 7:		
Antigens, Antigen-antibody interactions	Antigens, Superantigens, Adjuvants. Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions: Immunodiffusion and Immunoelectrophoresis techniques Agglutination reactions- Hemagglutination and complement fixation (C2, C3, C4. C6)	4
Unit 8:		

Transplantation Immunology	Major Histocompatibility Complex- H-2, HLA, Polymorphism of MHC molecules. Congenic and inbred strains of mice. MHC restriction and its role in immune response, Antigen presenting cells, Processing and presentation of antigens. (C1, C2, C3, C6).	3
Unit 9:		
Hypersensitivity	Hypersensitivity Reactions; Gell and Coombs, Classification; IgE Mediated (Type I) and Ab - mediated (Type II) Hypersensitivity Reactions Immune – complex-mediated (Type III) and TDTH mediated (Type IV) Hypersensitivity Reactions (C1, C2, C3).	3
Unit 10:		
Immune Tolerance, Autoimmunity, & Immunodeficiency	Immune tolerance: Central and peripheral tolerance of T cells and B cells. Autoimmunity; Definition, etiological factors and Autoimmune disorders (C1, C2, C3, C4)	4
Unit 11:		
Immunization & vaccination	Types of immunity – Innate and adaptive and immunization and vaccines and vaccination. Immune deficiency and its associated disorders.(C1, C2, C3, C5)	1

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x	x	x		
Quiz	x	x	x	x	x	x
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Kuby-Text book of Immunology, by Thomas J. Kindt (Author), Barbara A. Osborne (Author), Richard Goldsby (Author)

	• Basic Immunology: Functions and Disorders of the Immune System 6th Edition by Abul K. Abbas MBBS (Author), Andrew H. Lichtman MD PhD (Author), Shiv Pillai MBBS PhD (Author) • Review of Medical Microbiology and Immunology, Sixteenth Edition 16th Edition by Warren Levinson (Author) • Roitt's Essential Immunology (Essentials) 13th Edition by Peter J. Delves (Author), Seamus J. Martin (Author), Dennis R. Burton (Author), Ivan M. Roitt (Author)

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Cell and Tissue Engineering (Theory)**
Course Code: BBT 212	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with fundamentals of cell and tissue engineering, to provide fundamental knowledge of various tools and techniques used in cell biology and tissue engineering, and to understand the concepts of stem cell biology and its applications

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain various techniques in cell biology to a) separate cells b) to evaluate cellular functions and c) outline cell immortalization techniques (C1, C2, C3)
CO 2:	Explain origin, features and applications of stem cells (C2, C3)
CO 3:	Distinguish the various types of DNA damages and illustrate DNA repair mechanisms (C2, C4)
CO 4:	Outline principles and tools of tissue engineering (C2)
CO 5:	Explain applications of tissue engineering in the field of medicine (C1, C2)
CO 6:	Illustrate ethical issues related to tissue engineering (C2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×			×											
CO 2	×			×											
CO 3	×		×		×										
CO 4	×			×											
CO 5	×		×												
CO 6	×														

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction, principles and methodology isolation and characterization of primary cells	• Define and explain principles and methodology for isolating and characterizing primary (C1, C2) • Explain various cell separation techniques (C2, C3) • Identify cellular phenotypes using flow cytometry (C3)	5
Unit 2:		
Principle and methods for animal cell culture	• Illustrate various methods for assessing cellular functions such as cell proliferation, cytotoxicity, genotoxicity, migration, adhesion, apoptosis, cell cycle analysis (C2)	6
Unit 3:		

Cell Immortalization	• Define and explain different techniques used for immortalizing cells (C1, C2)	4
Unit 4:		
Stem cell biology	• Define and explain general concepts of stem cell biology • Define and distinguish features of embryonic stem cells and adult stem cells (C2, C3) • Evaluate the importance of therapeutic strategies of stem cells and outline bioethics of stem cell technology (C2, C3)	12
Unit 5:		
Introduction, principles and methods in tissue engineering	• Explain principles of tissue engineering including sources of cells, biomaterials and 3D printers (C2) • Outline the applications of tissue engineering in constructing models of various tissues (C2)	12
Unit 6:		
Bioreactors	• Explain design and applications of bioreactors (C1, C2)	3
Unit 7:		
Regulatory and ethical issues in tissue engineering	• Outline regulatory and ethical issues in tissue engineering (C1)	3

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	x		x		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback

Reference Material	• Freshney. Culture of Animal cells: a manual of basic and specialized application. 2016. 7th edition, Willey Blackwell Publishers. • Shay Fisher. Cellular and tissue engineering: concepts and application. 2016. World Scientific Publishers. • Ulrich Meyer, Thomas Meyer, Jorg Handschel, Hans Peter Wiesmann. Fundamentals of Tissue Engineering and Regenerative Medicine. 2013. Springer Publishers. • David Warburton. Stem Cells, tissue engineering and regenerative medicine. 2015. World Scientific Publishers

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Pharmacology and Pharmacogenomics (Practical)**
Course Code: BBT 214	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with various routes of drug administration; to acquire skills to demonstrate the various process of pharmacokinetics and drug induced cell toxicity; to understand the pharmacological principles using computer demonstrations; to acquire skills to use PCR based techniques to detect genetic variations; and DNA sequencing and advanced high throughput molecular analysis techniques for pharmacogenomic understanding.

Course Outcomes (COs):	At the end of the course student shall be able to:
CO 1:	Know about lab animals and to understand different mode of drug administrations (P1, P2)
CO 2:	Learn and demonstrate the skill to test the drug concentration in biological fluid (P1, P2)
CO 3:	Demonstrate the skills in performing in vitro pharmacokinetics studies related to toxicity, drug release (P1, P2, P3)
CO 4:	Understanding and performing skills and knowledge about the use of PCR based methods in pharmacogenomics (P1, P2, P3)
CO 5:	Understanding and performing skills and knowledge about the use of DNA sequencing in pharmacogenomics (P1, P2, P3)
CO6	Understand usage of different high throughput technologies (NGS, Microarray) for personalised medicine and to broadly understand analysis and interpretation of outcomes (P1, P2, P3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×														
CO 4	×			x				x							
CO 5	×			×				×							
CO 6	x			x				x							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Animal maintenance, handling and routes of administration	• To understand the basics of laboratory animal maintenance, handling, animal care and study of the routes of administration: oral, IM, IV, SC (P1, P2)	4

Unit 2:		
in vitro toxicity	• Skill to demonstrate in vitro toxicity of a given drug using human cell line models (P1, P2, P3)	4
Unit 3:		
Pharmacokinetic measurements of drugs	• Demonstrate the drug release in vitro (P1, P2, P3)	2
Unit 4:		
Detection of drug concentration in biological sample	• Skills to demonstrate detection of drug concentration in biological sample (P1, P2, P3)	4
Unit 5:		
Polymerase Chain Reaction (PCR) techniques	• Using the polymerase Chain Reaction (PCR) based techniques like PCR-RFLP for identifying SNPs important in pharmacogenetic testing (P1, P2, P3)	6
Unit 6:		
DNA sequence analysis to identify pharmacogenomic variations.	• Understand how Sanger sequencing is performed and a broad understanding of workflow and how the NGS can be used in pharmacogenetic (P1, P2, P3)	6
Unit 7:		
Microarrays and testing genome wide association of SNPs	• Understand how the microarray can be used in pharmacogenetic (P1, P2, P3)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	X	X	X		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	NA	x	NA	x	NA	NA
End Semester Examination						

Laboratory examination	X	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Badyal D., Practical Manual of Pharmacology for Medical Students, Jaypee Brothers Medical Publishers 2018 • Medhi B. and Prakash A, Practical Manual of Experimental and Clinical Pharmacology, Jaypee Brothers Medical Publishers, 2017 • Sambrook J and Russel DW. Molecular Cloning: A laboratory manual (3rd Edition) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York, 2001. • Walker, John M. (Series Ed.) Methods in Molecular Biology, Springer Nature 2013. • Head S.R., Ordoukhanian P., Salomon D.R. (Eds.) Next Generation Sequencing Methods and Protocols. Springer Nature 2018.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Plant Biotechnology (Practical)**
Course Code: BBT 216	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: II Year, IV Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This module helps to understand the practical applications of Plant Biotechnology, to provide fundamental knowledge on concepts of plant tissue culture, influence of types of nutrient media and growth regulators, and to understand the fundamental tools and technology for plant, cell, tissue and organ culture and promote large-scale propagation of disease free plants.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Outline the methods for preparation of optimal media for exclusive plant species
CO 2:	Demonstration of various methods to process and perform the experiment with various explants and learning methods to develop disease free plants.
CO 3:	Explain the fundamentals of somaclonal and gametoclonal variations and their impact on trait improvement of plants and discuss and illustrate the plant metabolite identification and product scale up strategies
CO 4:	Discuss the nature of explants and the proliferation capacities for different plant species, and comparative analysis of organogenetic and somatic embryogenic potentials
CO 5:	Conclude and combine the role of each experiments in relation with plant breeding, biotechnology and agriculture
CO 6:	Creating somatic hybrids and cybrids with protoplast isolation and fusion

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	x													
CO 2	×	x		x				x					x	x	
CO 3	×	x			X										x
CO 4	×	x		×		x						x			
CO 5	×	x													
CO 6	×	x								×			x		x

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Aseptic transfer and surface sterilization of explants and DNA	• Define and explain plant tissue culture concept, important milestones (C1, C2)	2

isolation from plants raised aseptically	• Understanding the types of plant tissue culture and its impact on agro-economic productivity (C2,C4) • Understanding the types of chemicals and the role in DNA isolation (C2,C4) • Defining and explaining the protocol of DNA isolation (C1, C2)	
Unit 2:		
Preparation of different nutrient media (MS, White, B5 media)	• Provide effective methods for media preparation (C2) • Explain media constitution (C2, C5) • Computing the strength of salts (C2) • Explain the methods of preparation of stock and working concentration (C2, C5) • Identification of elite media and growth hormone combinations ideal for plants (C2, C5)	2
Unit 3:		
Initiation of static cultures from different explants (root tip, shoot tip, leaf primordial, flowers)	• Classify the types of explants comparing their regeneration potential (C2) • Estimate and compare the output of plantlets from various explants (C5, C6)	4
Unit 4:		
Understanding the preparation of growth regulators and their combinatorial effects	• Define the fundamentals of stock preparations and storage (C1, C2, C5) • Explain the preparation of natural and synthetic growth regulator impact on plants (C2, C5, C6) • Demonstrate the potential applications of crop & horticultural improvement (C2). • Outline the mechanism of function of growth regulators (C2) • Analyse the proliferative properties of growth regulator combinations(C4)	2
Unit 5:		
Establishment of suspension cultures	• List the basic set up for initialising plant cell cultures (C1) • Discuss the role of plant growth regulators (both natural and synthetic) in raising single cell suspension culture (C6) • Explain different industrially valuable compounds from plant tissue culture and their scale up (C2, C5) • Illustrate and distinguish different phases of growth in plant cells (C2) • Explain the necessity of single plant cells (C6) • Categorize and compare the growth profiles of single cell suspension culture with respect to time and growth supplementations (C4, C5) • Understanding the role of exogenous and endogenous influencers of plant cell cultures (C6)	4
Unit 6:		
Protoplast Isolations from plant tissue	• Knowledge on isolation of protoplasts (C1, C2) • Viability assessments in protoplast • examples of stains for assessing the heath of protoplasts (C2, C4)	4

	• Characterization of health and yields of isolated protoplasts(C6) • Understanding the heterogeneous properties and doubling time in protoplasts (C1, C2)	
Unit 7:		
Protoplast fusion techniques	• Understanding the potential of protoplast doubling (C6) • Define use of fusogens and the types (C1,C2) • Illustrate the mechanism of fusion in protoplasts and types (C2) • Demonstrate the methods for chemofusion and its role in creating and selecting hybrids, cybrids and heterokaryons (C2) • Analyze and compare the protoplast fusion techniques and its capacity to develop trait improvement in crops (C4, C5)	6
Unit 8:		
Establishment of Hairy root cultures	• Define hairy root and the background (C1) • Explain the morphological differences between hairy root and normal roots (C2,C5) • Illustrate the mechanism of hairy root induction, its confirmation via molecular analysis and how it was exploited by plant biotechnologists (C2) • Explain the potential applications of hairy root culture in plants and its commercial significance (C2,C5) • Discuss the transgenic approaches employed by plant scientists across globe to bring trait improvement in crops (C1, C2, C5)	4
Unit 9:		
Analysis of secondary metabolites obtained from plant tissue using Thin layer chromatography	• Illustrate the methods of Thin layer chromatography (C2) • Explain the preparation of plant extract , loading principle and development of TLC plates (C2,C5) • Explain the information given by a TLC plate (C2,C5) • Explain the differences in a chromatography experiments yet explaining the simplicity and information given by TLC (C2,C5)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	x	x	x		
Quiz	X	x	x	x	x	x
Assignment/Presentation	X	x	x	x	x	x
End Semester Examination						
Laboratory examination	X	x	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Biological Science (3rd Ed) - Taylor DJ, Green NPO, Stout GW. - 2002 - Cambridge University Press • Micropropogation – Debergh PC, Zimmerman RH – 1990 - Kluwer Academic Publishers, Dordrecht. • Plant Cell Culture: A practical approach - Dixon RA, Gonzales - IRL Press. • Plant Molecular Biology – Goldberg RB – 1983 - Allan R Liss Inc. New York. • Plant Molecular Biology - Grierson D, Covey SN - Blackie, London. • Plant Tissue Culture – Concepts and laboratory exercise – Trigiano & Gray, 1999, 2nd Ed. CRC press. • Plant Tissue Culture Manual – Lindsey K – 1991- Kluwer Academic Publ, Dordrecht • Plant Tissue Culture: Applications and limitations – Bhojwani SS – 1990 - Elsevier, Amsterdam. • Transgenic plants Vol.1 & 2:- Kung S-D, Wu R – 1993 - Academic Press, San Diego

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Bioinformatics (Practical)**
Course Code: BBT 218	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This practical course will provide training in usage of bioinformatics tools and database for life science research and education.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Extract data from specific databases using accession, gene symbols, keywords and also build an advanced search query for performing the same (C1, C2, C3).
CO 2:	Apply the sequence alignment techniques to infer homology and perform phylogenetic analysis (C1, C4)
CO 3:	Make use of a visualization tool to visualize genomic data from different biological databases using a graphical interface and also download the same (C1, C2)
CO 4:	Identify and apply the tools to predict the secondary structures of protein sequences and 3D structure visualization (C2, C3)
CO 5:	Utilize the sequences for identification of restriction sites, virtual digestion and designing primers (C2, C3).

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	X		X							X					
CO 2	X				X	X				X					
CO 3	X			X						X					
CO 4	X				X	X				X					

CO 5	X				X					X					

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Exploring biological databases (Nucleotide - Genbank, Gene, Pathways - KEGG, Literature - PubMed), Drug Bank and PubChem	• Extract data from specific databases using accession, gene symbols, keywords and also build an advanced search query for performing the same (C1, C2, C3).	4
Unit 2:		
Sequence alignment: Sequence alignment techniques: Pairwise (BLAST), Multiple (CLUSTAL), phylogenetics (MEGA).	• Apply the sequence alignment techniques to infer homology and perform phylogenetic analysis (C1, C4)	4
Unit 3:		
Genome Browsers: Application and functionality of UCSC genome browser.	• Make use of a visualization tool to visualize genomic data from different biological databases using a graphical interface and also download the same (C1, C2)	6
Unit 4:		
Structural bioinformatics: Secondary structure prediction, PDB and Visualization of protein structures using DeepView,	• Identify and apply the tools to predict the secondary structures of protein sequences and 3D structure visualization (C2, C3)	8
Unit 5:		
Computational biology: Primer designing using Primer3 and *in silico* PCR, *In silico* Restriction mapping using NEBCutter	• Utilize the sequences for identification of restriction sites, virtual digestion and designing primers (C2, C3).	8

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5

Sessional Examination	X	x	x	x	
Quiz	NA	NA	NA	NA	NA
Assignment/Presentation	X	x	x	x	x
End Semester Examination					
Laboratory examination	X	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• PCR Protocols - A Guide to Methods and Application (1990); edited by, Michael A. Innis, David H. Gelfand, John J.Sninsky, Thomas J. White. Published by Academic Press. • Vincze, T., Posfai, J., & Roberts, R. J. (2003). NEBcutter: A program to cleave DNA with restriction enzymes. Nucleic acids research, 31(13), 3688–3691. https://doi.org/10.1093/nar/gkg526 • Wishart, D. S., Knox, C., Guo, A. C., Cheng, D., Shrivastava, S., Tzur, D., Gautam, B., & Hassanali, M. (2008). DrugBank: a knowledgebase for drugs, drug actions and drug targets. Nucleic acids research, 36(Database issue), D901–D906. https://doi.org/10.1093/nar/gkm958 • Berman, H. M., Westbrook, J., Feng, Z., Gilliland, G., Bhat, T. N., Weissig, H., Shindyalov, I. N., & Bourne, P. E. (2000). The Protein Data Bank. Nucleic acids research, 28(1), 235–242. https://doi.org/10.1093/nar/28.1.235 • Various online databases and open source tools.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Immunology (Practical)**
Course Code: BBT 220	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This practical course will help to understand the basic concepts and various immunological techniques that include antigen-antibody interactions, quantitation of antigens or antibody, ELISA etc.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Understand the basic concepts and would have hands on training for various immunological techniques., (C1, C2, C3, C4)
CO 2:	Understand how precipitation reactions can be used for the detection of immunoglobulin levels in the serum (C1, C2, C3, C4)
CO 3:	Knowledge in estimation of an unknown amount of antigen using immunoelectrophoresis techniques (C1, C2, C3, C4)
CO 4:	Understand agglutination reactions to assess the presence of antibodies in a specimen. (C2, C3, C4)
CO 5:	Understanding and estimating antigens and antibodies through the assays like ELISA (C1, C2, C4)
CO 6:	Learning and Understanding the principles of Flow cytometry and estimating the immune cells (Immunophenotyping) (C1, C2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×	x	X	×											
CO 2	×	x		×	x	x									
CO 3	×			×	x			x							
CO 4	×	x	X	×		x									

CO 5	×	x	X	×											
CO 6	×	x	X	×		x		x							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Blood Grouping	Hemagglutination assay for ABO blood group typing determination of and Rh factor (P1, P2, P3, P4)	4
Unit 2:		
Complete blood count	Determine differential leukocytes count and learn the basis of hematologic diseases (P1, P2, P4, P5, P6)	4
Unit 3:		
Lymphocyte Preparation	Isolation of lymphocytes from peripheral blood by ficoll method and checking the viability of isolated lymphocytes (P1, P2, P3, P4, P8)	6
Unit 4:		
Immunoprecipitation assays	Demonstration of Immunodiffusion assay for checking the identity of antigens. Estimation of an unknown amount of antigen using quantitative precipitation assay and performing. Immuno-electrophoresis of a given sample (P1, P2, P3, P4, P6)	6
Unit 5:		
Agglutination assays	Demonstration of hemagglutination and agglutination of latex beads in indirect agglutination assays (P1, P2, P3, P4)	2
Unit 6:		
Enzyme-Linked Immunosorbent assays	Determine the concentration of antigen by sandwich and Dot ELISA methods (P1, P2, P3, P4, P6, P8)	4
Unit 7:		
Immunophenotyping	Immunophenotyping of blood cells using Flow Cytometry and developing an ability to solve, analyse and interpret data generated. (P1, P2, P4, P6, P8, P10)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-based learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X	x	x	x		
Quiz	X	x	x	x	x	x
Assignment/Presentation	X	x	x	x	x	x
End Semester Examination						
Laboratory examination	X	x	x	x	x	x
Feedback Process	• End-Semester Feedback					
Reference Material	• Laboratory manual for Immunology experiments. • Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.					

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Cell and Tissue Engineering (Practical)**
Course Code: BBT 222	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquire hands-on training in fundamentals of cell and tissue engineering - to provide fundamental knowledge on techniques involved in isolation and characterization of primary cells from tissues, mammalian cell cultures and cell counting, to understand the various methods to assess cellular functions; and to provide fundamental knowledge of constructing 3D cultures
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the process of isolation and characterization of cells from tissues, perform mammalian cell cultures, cryopreserve and retrieve the cells (P1, P2, P3)
CO 2:	Experiment and enumerate cell numbers, evaluate cytotoxicity and categorize cells based on markers (P2, P5)
CO 3:	Demonstrate the process of 3D cell culture (P2, P5)
CO 4:	Explain principles of fluorescence microscopy (P5)

Mapping of COs to POs

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO 1	×		×		×	×		×							
CO 2	×			×	×			×							
CO 3	×		×	×				×							
CO 4	×					×		×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Introduction and design of cell biology laboratory	• Explain design of cell biology lab and describe various instruments used to study cells (P1, P2, P3)	2
Unit 2:		
Animal cell culture	• Demonstrate sub-culturing the mammalian cells (P2)	4
Unit 3:		
Retrieval and cryopreservation of cells	• Outline the process of retrieval and cryopreservation of cells (P3)	2
Unit 4:		

Cell counting using hemocytometer	• Apply the method of cell counting using hemocytometer (P3)	4
Unit 5:		
Cytotoxicity assays (MTT assay)	• Analyse cytotoxicity using MTT assay (P4)	2
Unit 6:		
Flow cytometry- Principles and concept, and (a) Cell cycle analysis (b) Immunophenotying	• Explain principles of flow cytometry (P2) • Evaluate cell cycle phases and identification of cells using flow cytometry (P2)	4
Unit 7:		
Fabrication of nano-fibrous scaffold	• Understanding the principles of electrospinning (P2)	2
Unit 8:		
3D culturing using scaffolds	• Explain methods involved in 3D cultures and evaluate its application in angiogenesis, construct generation (P2, P3)	6
Unit 9:		
Fluorescence microscopy	• Explain principles and applications of fluorescence microscopy (P3)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	**37**	**90**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination	X	x		
Quiz	NA	NA	NA	NA
Assignment/Presentation	X	x	x	X
End Semester Examination				
Laboratory examination	X	x	x	X

Feedback Process	• End-Semester Feedback
Reference Material	• Freshney. Culture of Animal cells: a manual of basic and specialized application. 2016. 7th edition, Willey Blackwell Publishers.

	• Shay Fisher. Cellular and tissue engineering: concepts and application. 2016. World Scientific Publishers. • David Warburton. Stem Cells, tissue engineering and regenerative medicine. 2015. World Scientific Publishers. • Harris, Graham and Rickwood. Cell biology protocols. 2006. Wiley & Sons., Ltd.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Seminar/Journal Club**
Course Code: BBT 224	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: II Year, IV Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course will include an allotment of an individual seminar topic related to the semester courses. This will enhance students' knowledge base and expose them to how to present information clearly and concisely. Students will also learn how to compile the literature database information.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react
CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks, and learn how to compile and interpret data.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×													
CO 4		×													
CO 5		×													
CO 6		×													

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual seminar topic related to the semester courses	30 minutes oral presentation for each student

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	15	45
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		

Assessment	01	-
TOTAL	**16**	**45**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	-

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	X	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the seminar topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Microbial Biotechnology (Theory)**
Course Code: BBT 301	**Course Instructor: Course In-charge**
Academic Year: 2022-2023	**Semester: III Year, V Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis :	This course introduces and provides knowledge in two major fields of biotechnology using microorganisms – food microbiology and bioprocess engineering.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	List and describe the sources, types, incidence and significance of microorganisms in food (C1, C2)
CO 2:	Define and explain major characteristics of food spoilage, and apply suitable preservation methods to overcome food spoilage (C1, C2, C3)
CO 3:	Determine methods of culturing microorganisms in food (C2, C4)
CO 4:	Describe and apply suitable quality standards for food preservation and understand their significance (C2, C3)
CO 5:	Define and describe the fermentation process through description of microorganisms and their improvement, media requirements, fermenter parts and types, and the methods associated (C1, C2)
CO 6:	Provide examples for fermentation processes using microorganisms (C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×							×							
CO 3	×		×												
CO 4	×		×	×	×										
CO 5	×														
CO 6	×									×					

Course content and outcomes:

Content	*Competencies*	*No of Hours*

Unit 1:		
Historical background, predominant microbes in food – bacteria and fungi, sources of microbes in food, beneficial uses of microbes in food	List and describe the sources, types, incidence and significance of microorganisms in food (C1, C2)	5
Unit 2:		
Factors influencing microbial growth in food and food spoilage, indicators of food spoilage, foodborne diseases	Define and explain major characteristics of food spoilage, and apply suitable preservation methods to overcome food spoilage (C1, C2, C3)	5
Unit 3:		
Methods to determine food-borne pathogens	Compare and analyse methods of culturing microorganisms in food (C2, C4)	4
Unit 4:		
Methods to control microbes in food – irradiation, heat, temperature, pH, water activity, preservatives	Outline suitable quality standards for food preservation and explain their significance (C2, C3)	4
Unit 5:		
Quality assurance in foods, HACCP principles, biosensors in food industry, GM foods	Outline suitable quality standards for food preservation and explain their significance (C2, C3)	3
Unit 6:		
Introduction to Fermentation	Define and explain the fermentation process through description of microorganisms and their improvement, media requirements, fermenter parts and types, and the methods associated (C1, C2)	4
Unit 7:		
Production strains	Define and explain the fermentation process through description of microorganisms and their improvement, media requirements, fermenter parts and types, and the methods associated (C1, C2)	4
Unit 8:		
Media	Define and explain the fermentation process through description of microorganisms and their improvement, media requirements, fermenter parts and types, and the methods associated (C1, C2)	4
Unit 9:		
Fermenter	Define and explain the fermentation process through description of microorganisms and their improvement, media requirements, fermenter parts and types, and the methods associated (C1, C2)	3
Unit 10:		
Fermentation	Define and explain the fermentation process through description of microorganisms and their improvement, media requirements, fermenter parts and types, and the methods associated (C1, C2)	5
Unit 11:		
Products of fermentation	Explain and identify specific examples for fermentation processes using microorganisms (C2, C3)	4
Learning strategies, contact hours and student learning time		

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×	×		
Quiz						
Assignment/Presentation						
End Semester Examination	×	×	×	×	×	×
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	End-Semester Feedback
Reference Material	• Adams MR, Moss MO. Food Microbiology (3rd ed.), RSC Publishing, Cambridge 2000 • Frazier WC, Westhoff DC. Food Microbiology (4th ed.), Tata McGraw-Hill Publications, 2008 • Ray B. Fundamental Food Microbiology (3rd ed.), CRC Press, Boca Raton, 2005 • Stanbury PF, Whitaker A, Hall SJ. Principles of Fermentation Technology (2nd ed.), Butterworth-Heinemann, 1995 • Shuler ML, Kargi F. Bioprocess engineering - Basic concepts, Prentice Hall, 1992 • Patel AH. Industrial Microbiology, Macmillan India Press, 2000

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Developmental Biology (Theory)**
Course Code: BBT 303	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with the basics of Developmental biology, knowledge of early, late, and post-embryonic development, the role of parthenogenesis, regeneration, and their applications, the medical implications of developmental biology, and also the role of stem cells and their applications in biotechnology.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the concepts of development and the process of spermatogenesis & oogenesis, and patterns of development (C2, C5)

CO 2:	Explain the process of pre- and post-embryonic development including organ systems (C2, C5)
CO 3:	Illustrate the embryogenesis (somatic and zygotic) in plant systems (C2)
CO 4:	Explain different types of parthenogenesis and the significance of parthenogenesis in plants and animals (C2, C5)
CO 5:	Explain the phenomena of regeneration (stem cells) and its applications (C2. C5)
CO 6:	Discuss the medical implications of developmental biology including teratogenesis, morphological defects mechanism, and congenital malformations (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×		x												
CO 4	×		x												
CO 5	×		x												
CO 6	×			x	X			x	x						

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Basic concepts of development	History and basic concepts of developmental biology. Mechanisms of differentiation & growth including morphogenetic movements. (C2, C5)	2
Unit 2:		
Early embryonic development	Gametogenesis (spermatogenesis and oogenesis). Fertilization includes types of eggs and egg membranes. Oviparity, ovoviviparity an,d viviparity. Cleavage; types, planes, and patterns. The process of early embryonic development including fate maps and cell lineages, presumptive organ forming areas, blastula, gastrulation, embryonic induction and organizers (C1, C1, C2, C4,C5)	10
Unit 3:		
Late embryonic development	Placental types, Neurulation including neural crest development and directed cell migration. (C1, C2, C4, C5)	6
Unit 4:		
Post embryonic development	Provide an outline of organogenesis. Explain and compare the development the of nervous system, limb, eye, face, pharyngeal apparatus, cardiovascular system, respiratory system, gastrointestinal system, endocrine system, urogenital system. (C2, C4, C5).	8
Unit 5:		
Plant embryogenesis	Micro- and mega-sporogenesis, the developmental pattern of embryos, type of ovules and embryos. Root and shoot development, somatic and zygotic embryogenesis. Seed architecture (development and function), dormancy, germination, differentiation, de- and re-differentiation). (C1, C2,C5)	6
Unit 6:		
Plant regeneration and applications	Regeneration; epimorphosis, morphallaxis and compensatory regeneration. Regeneration in planarians and amphibians. Embryonic stem cells and ethics. Multiple ovulation and embryo transfer technology, cloning of animals by nuclear transfer (C2, C4, C5,C6)	5
Unit 7:		

Parthenogenesis	Parthenogenesis; Natural parthenogenesis (arhenotoky and thelytoky) and artificial parthenogenesis Parthenogenic significance in plants and animals (C1, C2, C5, C6)	4
Unit 8:		
Stem cells	Stem cell; potency, types, differentiation, and their applications in biotechnology Explain the types and developmental programs of stem cells. (C2, C5, C6)	2
Unit 9:		
Medical implications	Teratogens, morphological defects, and genetic mechanisms of congenital malformations (C2, C4)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	X		x	x		
Quiz						
Assignment/Presentation	X	x	x	x	x	
End Semester Examination	X	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. ISBN-10: 9780878933846. • Plant Embryogenesis, María F. Suárez and Peter V. Bozhkov (Eds.), Humana Press, a part of Springer Science+Business Media, LLC, 2008 • Plant Tissue Culture: Applications and limitations – Bhojwani SS – 1990 - Elsevier, Amsterdam. • Micropropogation – Debergh PC, Zimmerman RH – 1990 - Kluwer Academic Publishers, Dordrecht. • Phytohormones: A Window to Metabolism, Signaling and Biotechnological Applications. Tran, Lam-Son, Pal, Sikander (Eds.), Springer Science+Business, New York, 2014.

	• Plant Propagation by Tissue Culture 3rd Edition Volume 1. The Background, Edwin F. George, Michael A. Hall, Aberystwyth, and Geert-Jan De Klerk (Eds), Springer, The Netherlands.2008

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Advanced Genomics (Theory)**
Course Code: BBT 305	**Course Instructor: Course in-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to: • acquaint the students with fundamentals of genomics and advanced molecular biology techniques • provide fundamental knowledge of prokaryotic and eukaryotic genomes, epigenetics and functioning of genome • understand the applications of tools and techniques used in genome science
Course Outcomes (COs):	On successful completion of the course, students will be able to
CO 1:	Explain the structure and organization of prokaryotic and eukaryotic genomes and regulatory elements (C1, C2)
CO 2:	Explain human genome project and its applications (C2, C3)
CO 3:	Describe the various types of epigenetic regulations for gene expression and techniques to understand epigenetic processes (C1, C2, C3)
CO 4:	Describe the various tools and methods used for genome analysis along with their applications (C1, C2, C3, C4)
CO 5:	Explain the concepts of pharmacogenomics and its applications, and genome evolution and molecular phylogenetics (C1, C2, C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×			×											
CO 2	×			×											
CO 3	×		×		×										
CO 4	×			×											
CO 5	×		×												

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Prokaryotic genome – structure and organization of prokaryotic genomes, concept of operons, regulatory elements and their roles in functions of *lac* and *trp* operons	• Define physical structure and organization of prokaryotic genome (C1, C2) • Explain regulatory elements with OPERON system as example (C2)	5
Unit 2:		
Eukaryotic genome – structure and organization of eukaryotic genomes, features of nuclear and organelle genomes	• Define structure and packaging of eukaryotic genome and distinguish from prokaryotic genome (C1, C2) Outline features of chromosomes and organelle genomes (C2)	5
Unit 3:		

Human Genome Project – overview, inception and timelines, goals and objectives, strategies followed, outcomes and achievements, ELSI program, applications, human diversity	• Explain overview of human genome project and its application in the field of medicine (C2) • Explain human genome diversity (C2) • Evaluate importance of mapping strategies (C3)	5
Unit 4:		
Genome functioning – repeat elements in genomes, classification, function	• Explain repetitive DNA content of genomes and their classification (C2).	3
Unit 5:		
Epigenetics - DNA methylation, histone modifications and regulatory RNAs. Imprinting, techniques used in genome analysis	• Explain epigenetic modifiers for regulation of gene expression (C2). • Explain genome imprinting (C2) • Examine various techniques used for epigenome analysis (C4)	6
Unit 6:		
Genome analysis methods and tools – enzymes used in genetic engineering and their features and applications, cDNA synthesis methods, cloning methods, screening methods for DNA and cDNA libraries	• Outline characteristic features and functions of enzymes for genetic engineering (C2) • Explain methods for cDNA synthesis and cloning (C5) • List the methods for screening cDNA and genomic library (C4)	6
Unit 7:		
DNA sequencing and analysis of genome variations	• Outline the tools for analysing genome variations (C2) • Explain various methods of applications for genome analysis (C3)	5
Unit 8:		
Pharmacogenomics – concepts, history and evolution, methods, importance and applications of personalized medicine	• Define concepts in pharmacogenomics (C1) • Discuss history and evolution of pharmacogenomics (C3) • Evaluate importance and applications of personalized medicine (C5)	7
Unit 9:		
Genome evolution and comparative genomics	• Explain various theories for genome evolution (C2) • Explain principles, objectives and methods of molecular phylogenetics (C3) • Discuss importance of comparative genomics (C2)	3

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		

Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs					
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5
Sessional Examination	×	×		×	
Quiz	×	×	×	×	×
Assignment/Presentation	×	×	×	×	×
End Semester Examination	×	×	×	×	×
Laboratory examination	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Introduction to Genomics, by Arthur M. Lesk; Oxford University Press. • Human Genetics and Genomics by Bruce R. Korf and Mira B. Irons; Willey Blackwell. • Human Molecular Genetics by Tom Strachan and Andrew Read; Garland Science. • Genomics and Personalized Medicine: What Everyone Needs to Know, by Michael Snyder; Oxford University press. • Genomes 3, by T. A. Brown; Garland Science. • Molecular Biology of the Cell 6th Edition, by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Nanobiotechnology (Theory)**
Course Code: BBT 307	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course introduces and provides knowledge about the synthesis and characterisation of nanoparticles with various methods. It provides fundamental knowledge of applications of nanomaterials in the field of biotechnology.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the history and basic concepts of nanoscience (C1)
CO 2:	Study the variation in physical and chemical properties of nanoparticles with size (C1)
CO 3:	Discuss the various synthesis (Lithography, Sol-Gel, Chemical reduction, Ball milling etc.,) methods used in synthesis of polymeric nanoparticles, carbon nanotubes, dendrimers Discuss the working principle and applications of various characterisation techniques (AFM, SEM, TEM) used in nanotechnology. (C1, C2, C3)
CO 4:	Explain the use of different nanoparticles (solid lipid nanoparticles, synthetic and biopolymeric nanoparticles, carbon nanotubes, polymeric nanofibers) as drug carriers (C1, C2)

CO 5:	Discuss the applications of nanotechnology in various fields (Therapy, Diagnostics, plant biotechnology etc.,) (C2)
CO 6:	Understand the principle and mechanism of nanotoxicity (C1, C2, C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×														
CO 3	×														
CO 4	×		×												
CO 5	×							×							
CO 6	×												×		

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Fundamentals of Nanoscience and Nanotechnology	• Outline the history of nanotechnology development (C1) • Explain the basic concepts of nano science, nanobioscience and technology (C1) • List the technological advantages of nanomaterials (C1)	2
Unit 2:		
Properties of Nanomaterials	• What are the Physical properties, Chemical properties and Surface properties of nanomaterials (C1)	2
Unit 3:		
Synthesis and Characterization of Nanomaterials	• Discuss Top-down approaches of nanoparticle synthesis (C2) • Explain vapor deposion (chemical vapor deposition physical vapor deposition) Sol-gel processing and chemical synthesis, lithography of nanoparticle synthesis (C2) • Synthesis of carbon based nanomaterials Carbon nanotube Arch discharge, Lase ablation (C1, C2) • Synthesis of Dendrimers, polymeric nanoparticles (C1, C2) • Compare TEM, SEM and Scanning Probe Microscopy (SPM) AFM, Scanning Tunneling microscope techniques. (C1, C2, C3)	12
Unit 4:		
Nanobiotechnology	• Explain the synthesis and applications of magnetic nanoparticles (C2) • Explain the importance of nanoparticles for drug delivery (C2) • What is controlled drug delivery? (C1) • List the ideal properties of nanoparticles for drug delivery. (C1) • Compare and contrast active and passive targeting (C4) • Explain pH and temperature responsive polymers used for drug delivery.(C2) • Explain the applications of following nanoparticles in drug delivery: solid lipid nanoparticles, synthetic and biopolymeric nanoparticles, carbon nanotubes, polymeric nanofibers (C2)	12
Unit 5:		
Applications of Nanotechnology	• Summarize diagnostic applications of nanoparticles (C2) • Explain the nanomaterials used in therapeutic applications(C2)	6

	• Explain how nanoparticles are used in developing molecular devices (C2) • Explain the implications of nanomaterials in neuroscience, tissue engineering and cancer therapy (C2) • Summarize the applications of nanomaterials in plant biotechnology (C2)	
Unit 6:		
Environmental and safety aspects of Nanotechnology	• What is Nanopollution? List the Nanomaterials in environment which causes pollution.(C1, C4) • Explain toxicology of airborne manufactured nanomaterials in the environment.(C2) • Explain the mechanism of nanosize particle cellular toxicity.(C2) • What are the safety aspects of nanotechnology? (C1)	11

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x		x	x		
Quiz				x		
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• Niemeyer CM, Mirkin CA. Nanobiotechnology, Concepts, Applications and perspectives, Wiley-VCH, Verlag GmbH & Co. 2004 • deVilliers MM, Aramwit P, Kwon GS. Nanotechnology in Drug Delivery, Springer-American Association of Pharmaceutical Scientists Press, 2009 • Rozlosnik N. Nanomedicine in Diagnostics, Science Publishers, 2012 • Zhao Y, Nalwa HS. Nanotoxicology: Interactions of Nanomaterials with Biological Systems, American Scientific Publishers, 2007

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Research Methodology (Theory)**
Course Code: BBT 309	**Course Instructor: Course In-charge**
Academic Year: 2023 Onwards	**Semester: III Year, V Semester**
No of Credits: 3	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course provides knowledge and understanding with the concepts of research, literature review and research design. Further to impart the facts related quality and biosafety, good laboratory practices, good manufacturing practices, various regulatory bodies and also to understand the importance of research, scientific writing and ethical issues involved.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Define and explain the basic concept and types of research (C1, C2, C5)
CO 2:	Understand the importance of literature review and to formulate a research problem. Understand and explain the scientific design (C2, C5, C6)
CO 3:	Designing of research method including test models, techniques, obtaining data, case studies, statistics and interpretation of results (C6)
CO 4:	Define and explain the different kinds of scientific documents and presentations. (C1, C2, C5)
CO 5:	Explain the Biosafety issues in research and handling of hazardous material. Explain the ethics involved in research (C1, C2, C5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×				×	×			×						
CO 2	×		×		×	×									
CO 3	×		×	×	×	×		×							
CO 4	×	×	×		×	×		×							
CO 5	×		×		×	×							×		

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Research concept	• Define and outline the basic concept of research (C1, C2) • Classify and explain the types of research such as Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical; Research process; main components of any research (C2, C4, C5)	5
Unit 2:		
Literature Review	• Summarize and explain the importance of review of research reports and journal articles (C2, C5)	3
Unit 3:		
Designing scientific research	• Design the basic scientific research, formulate hypothesis (C6) • Define and elaborate the formulation of research problem; characteristics, role and tests of hypothesis (C1, C6) • Outline aim of the investigation; objectives of research; experimental design and Timeline (C2) • Explain the importance of Laboratory notebook and documentation criteria (C2, C5)	6
Unit 5:		

Research Methods	• Selection of test models and techniques (C1) • Discuss research design, sampling design, data collection, observation methods, questionnaires, case study methods (C6) • Process, analyse and interpret the data statistically (C4)	5
Unit 6:		
Scientific Writing	• Define scientific writing and explain different kinds of scientific documents such as (research paper, review paper, book reviews, theses, conferences, project reports and research project proposals to funding agencies) (C1, C2, C5) • Explain and outline the importance of oral and poster presentation of research papers in conferences/symposia and effective presentation skills; Scientific editing tools (C2, C5)	10
Unit 7:		
Quality and safety and Ethical issues	• Evaluate quality assessment and consciousness (C5) • Explain and justify the importance of Good laboratory practices, Good manufacturing practices, Food and Drug administration, Central drugs standard control organization guidelines (C2, C5) • Importance of biosafety issues; standard operation procedure; procurement, storage, usage and safe disposal of hazardous materials and material safety data sheet (C5) • Ethical Committees and Ethics in research; Informed consent; IBSC; IPR and Patent	16

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	45	135
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	05	-
TOTAL	**50**	**135**

Assessment Methods:

Formative:	Summative:
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	x	X	x	x		
Quiz						
Assignment/Presentation		X	x	x	x	x
End Semester Examination	x	X	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	• How to write a scientific paper. Robert A Day. IEEE • Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, SAGE, 2005. • Geoffrey R. Marczyk, David DeMatteo& David Festinger, Essentials of Research Design and Methodology, John Wiley & Sons, 2004. • John W. Creswel, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE, 2004. • Suresh C. Sinha and Anil K. Dhiman, Research Methodology (2 Vols-Set), Vedam Books, 2006. • C. R. Kothari, Research Methodology: Methods and Techniques, New Age International Publisher, 2008. (and 2015, available online) • R. Pannershelvam, Research Methodology, Prentice Hall, India, 2006. • Manfred Max Bergman, Mixed Methods Research, SAGE Books, 2006. • Paul S. Gray, John B. Williamson, David A. Karp, John R. Dalphin, The Research Imagination, Cambridge University press, 2007. • Cochrain & Cox, Experimental Designs, II Edn. Wiley Publishers, 2006. • Text Book on Intellectual Property Right, N K Acharya; 6th ed; 2012. • Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. J W. Creswell; 3rd ed. • Staff, World Health Organization (2009) Handbook: Good Laboratory Practice (GLP) (Available online). • P. Oliver. A student's Guide to Research Ethics. Open University Press. 2010 (Available online)

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Microbial Biotechnology (Practical)**
Course Code: BBT 311	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This practical course introduces and provides knowledge and technical skills in microbial biotechnology.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	List and illustrate the basic methods in microbial biotechnology (C1, P2)
CO 2:	Isolate microorganisms from the environment and obtain pure culture and identify pathogenic microorganisms using PCR (P2, P4)
CO 3:	Name, explain and qualitatively analyse enzyme activity (P2, P3, P4)
CO 4:	Estimate biomass and analyse growth curve patterns of microbes and to detect microbes in raw and processed food materials (P1, P2)
CO 5:	Demonstrate the ability to qualitatively differentiate milk (P2, P4)
CO 6:	Explain the principle and demonstrate citric acid production (P2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×														
CO 2	×		×					×							
CO 3	×				×			×							
CO 4	×		×					×							

CO 5	×		×		×			×							
CO 6	×						×	×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Basic methods in microbial biotechnology	• List and explain the basic methods in microbial biotechnology (C1, P2)	2
Unit 2:		
Isolation of microbes from environment and obtaining a pure culture	• Explain methods to isolate microorganisms from the environment and obtain pure culture (P2)	4
Unit 3:		
Identification of pathogens by PCR	• Analyze the presence of pathogenic microorganisms using PCR (P2, P4)	4
Unit 4:		
Qualitative assay of enzymes	• Name, explain and examine methods to analyse enzyme activity (C1, P2, P3, P4)	4
Unit 5:		
Biomass estimation	• Explain methods to study biomass and analyse growth curve patterns of microbes (P2)	2
Unit 6:		
Bacterial growth curve analysis	• Explain methods to study biomass and analyse growth curve patterns of microbes (P2)	4
Unit 7:		
Methylene blue reduction test for examining presence of microbes in milk	• Demonstrate and analyse methods to qualitatively differentiate milk (P2, P4)	2
Unit 8:		
Turbidity test for Pasteurization	• Demonstrate and analyse methods to qualitatively differentiate milk (P2, P4)	2
Unit 9:		
Examination of raw and processed food	• Outline methods to study microbial numbers in raw and processed food materials (P1, P2)	4
Unit 10:		
Laboratory-scale production of citric acid	• Explain the principle and demonstrate citric acid production (P2)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-

TOTAL	37	90

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	×	×	×	×		
Quiz						
Assignment/Presentation						
End Semester Examination						
Laboratory examination	×	×	×	×	×	×

Feedback Process	• End-Semester Feedback
Reference Material	• D.K. Maheshwari, Practical Microbiology, Chand publishers, India, 2010 • Mukesh Kumar, Practical Manual for Undergraduates Microbiology, Jain Brothers India, 2010

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Developmental Biology (Practical)**
Course Code: BBT 313	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with hands on training on basics of developmental biology, structure and development of sperms, egg, embryos; histology of reproductive organs.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Learn and illustrate and analyse different types of eggs and sperms, factors affecting sperm quality and fecundity (P2, P3)
CO 2:	Understand and perform about the plant embryogenesis and artificial seed germination (P2, P4)
CO 3:	Compare the developmental stages in Drosophila/C. elegans/Frogs and Chicks and to learn the techniques to study the developmental stages (P2, P3)
CO 4:	Learn to perform, identify, explain and Analyse the histological changes in mammalian reproductive organs (P2, P3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×		x					x							
CO 2	×		x		x			x							
CO 3	×		×		x			×							
CO 4	×		x		×			×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		

Study of tissue structure	• Observe and analyse the histology of mammalian reproductive organs (P2)	2
Unit 2:		
Study of sperms	• Identify, analyse the abnormalities in the mammalian sperms (P2, P3)	2
Unit 3: Plant embryogenesis	• Explain, analyse and demonstrate various types of embryos (P2, P4)	2
Unit 4:		
Preparation of Artificial seeds	• Illustrate and perform the preparation of artificial seed preparation and germination (P2, P4)	4
Unit 5:		
Study of early developmental stages	• Perform, identify, illustrate the different stages of embryo development in Drosophila and isolate egg chamber (P2, P3)	6
Unit 6:		
Developmental biology of seed embryo	• Demonstrate the radicle and plumule developmental patterns under different environmental conditions	2
Unit 7:		
Fecundity	• Demonstrate and analyse egg laying capacity in Drosophila and role of various factors on the same	2
Unit 8:		
Development of Hen's Egg	• Perform the window technique on Hen's egg to analyse the development (P2, P4)	4
Unit 9:		
Determination of plant cell growth	• Establishment of suspension culture and determination of cell growth under different environmental conditions	6

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination	X	x		

Quiz				
Assignment/Presentation				
End Semester Examination				
Laboratory examination	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Vijayakumarn Nair, K. and George, P. V. (2002). A manual of developmental biology, Continental publications, Trivandrum. • Melissa A and Gibbs. (2006). A practical Guide to Developmental Biology, Oxford university press (Int. student edition). ISBN: 9780199249718. • Trigunayat M.M. (2019). A Manual of Practical Zoology: Biodiversity, Cell Biology, Genetics & Developmental Biology Part 1. Scientific Publishers, India, ISBN-10: 938844907X • Plant Tissue Culture: Applications and limitations – Bhojwani SS – 1990 - Elsevier, Amsterdam. • Plant Propagation by Tissue Culture 3rd Edition Volume 1. The Background, Edwin F. George, Michael A. Hall, Aberystwyth, and Geert-Jan De Klerk (Eds), Springer, The Netherlands.2008. • Plant cell culture protocols. Victor M. Loyola-Vargas and Felipe Vázquez-Flota (Eds) – 2nd. ed. Humana press Inc, Totowa, New Jersey. 2006.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Advanced Genomics (Practical)**
Course Code: BBT 315	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	The objectives of this course are to acquaint the students with various methods of practical experimentation in advanced genomics and outcome analysis. This includes understanding the principles behind the mapping of plasmids and acquiring skills and techniques of restriction digestion, concepts behind the Polymerase chain reaction, learning isolation of RNA, and visualization. Demonstration of advanced molecular techniques and the conceptual basis for RNA expression and genome-wide DNA analysis and their application for molecular genetic studies based on real-time PCR, DNA sequencing, microarrays, and next-generation sequencing is a highlight of the course.
Course Outcomes (COs):	At the end of the course, students shall be able to:
CO 1:	Perform and interpret Restriction digestion and mapping of plasmids. (P1, P2, P3)
CO 2:	Perform Polymerase Chain Reaction for various purposes
CO 3:	Perform and interpret results of Polymerase chain reaction (PCR) - restriction fragment length polymorphism (PCR-RFLP) (P1, P2, P3)
CO 4:	Understand the principle and method for RNA isolation and know the method and explain the real Time-PCR: principle, applications, etc (P1, P2, P3)
CO 5:	Perform and understand the concept behind denaturing agarose gel electrophoresis for RNA (P1, P2, P3)
CO 6:	Knowledge of methods to Perform and understand the concept behind DNA sequencing, analysis and next generation sequencing (P1, P2 P3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	X		X	X											

CO 2	X		X			X									
CO 3	X		X			X									
CO 4	X		X			X									
CO 5	X		X			X		X							
CO 6	X		X		X	X		X							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Restriction digestion and mapping of plasmids.	Knowledge of the method for digestion of plasmids with restriction endonucleases and the understand concepts behind mapping (P1, P2, P3)	4
Unit 2:		
Polymerase chain reaction	Understanding the concept of Polymerase chain reaction and knowledge to apply the method (P1, P2, P3)	2
Unit 3:		
Polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP)	Performing and interpreting results of Polymerase chain reaction- restriction fragment length polymorphism (P1, P2, P3)	4
Unit 4:		
RNA isolation	Knowledge of the principle and method for RNA isolation (P1, P2, P3)	2
Unit 5:		
Denaturing agarose gel electrophoresis for RNA	Understanding of the concept behind denaturing agarose gel electrophoresis for RNA and the method to perform (P1, P2, P3)	2
Unit 6:		
Real Time-PCR: principle, applications- demonstration	Learning of the method and explanation about working of the real Time-PCR: principle, applications etc. (P1, P2, P3)	4
Unit 7:		
DNA sequencing and analysis	Knowledge of concept and method to Perform and understand the DNA sequencing and analysis of outcome (P1, P2, P3)	4
Unit 8:		
Demonstration of DNA microarray experiment	Understanding of the principle behind method concept of DNA microarray experiment with an overview for applications (P1, P2, P3)	4
Unit 9:		
Next Generation sequencing: overview.	Knowledge of the principle behind, and method of Next Generation Sequencing: with an overall view (P1, P2, P3)	4

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-

TOTAL	37	90

Assessment Methods:	
Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO3	CO4	CO5	CO6
Sessional Examination	X	X	X	X		
Quiz						X
Assignment/Presentation	X	X	X	X	X	
End Semester Examination						X
Laboratory examination	X	X	X	X	X	X

Feedback Process	• End-Semester Feedback
Reference Material	• Sambrook J and Russel DW. Molecular Cloning: A laboratory manual (3rd Edition) COLD SPRING HARBOR LABORATORY PRESS Cold Spring Harbor, New York, 2001. • Walker, John M. (Series Ed.) Methods in Molecular Biology, Springer Nature 2013. • Head S.R., Ordoukhanian P., Salomon D.R. (Eds.) Next Generation Sequencing • Methods and Protocols. Springer Nature 2018.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Nanobiotechnology (Practical)**
Course Code: BBT 317	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This practical course introduces and provides knowledge and technical skills in nano biotechnology.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Synthesize nanoparticles with various methods (P1, P2)
CO 2:	Explain the principle of characterisation nanoparticles with various method (P2)
CO 3:	Understand the principle and mechanism of nanotoxicity. Also to learn methods to determine cytotoxicity (P2)
CO 4:	Study drug release kinetics (P1, P2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1	×		×		×										
CO 2	×				×	×									
CO 3	×												×		
CO 4	×							×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Instrumentation (AFM, SEM, NMR, IR, UV spectroscopy, Zetasizer, Rotary Evaporator,	• Identify the instruments (P2) • Demonstrate the working of instruments used in synthesis and characterisation of nanoparticles (P2)	4

Lyophiliser, Ball mill, High Pressure homogenizer, High Speed homogenizer, Scatteroscopy, Nitrogen evaporator)	• Summarise the working principle of the instruments (P2)	
Unit 2:		
Synthesis of gold nanoparticles.	• List the applications of gold nanoparticles in the field of biotechnology (P1) • Make use of trisodium citrate reduction method to synthesis of gold nanoparticles (P3) • Explain variation in the size of gold nanoparticles by varying the concentration of reducing agent. (P2) • Demonstrate the Bottom up approach for the synthesis of nanoparticles (P2)	4
Unit 3:		
Synthesis of silver nanoparticles – Sweet /Green Nanochemistry/ Microemulsion	• Make use of hot plate or domestic microwave oven to synthesize the silver nanoparticles (P3) • Synthesis of silver nanoparticles by microemilsion (P2) • Summarise the green chemistry principles and its application for silver nanoparticle synthesis (P2) • Explain the use of spectrophotometer to calculate particle size (P2)	4
Unit 4:		
Microwave synthesis of zinc hydroxy sulphate Nano plates and zinc oxide nano rods.	• Show the synthesis of zinc hydroxyl sulfate nanoplates and zinc oxide nanorods (P2) • Comparison of different morphologies (rods/plates) of nanoparticles obtained by changing the reagent concentrations and ratio. (P2)	2
Unit 5:		
Estimation of IC50 of nanoparticles against cell lines growing *in vitro*	• Understand the toxicity of nanoparticles (P2) • List the different assays to determine the cell toxicity (P1) • Demonstrate the MTT Assay to find the IC50 of nanoparticles (P2) • Find and Interpret IC50 (P1, P2)	2
Unit 6:		
Antimicrobial activity of nanoparticles.	• List the nanoparticles used in antimicrobial therapy (P1) • Demonstrate the antimicrobial activity of nanoparticles (P2) • Find minimum inhibitory concentration (P1)	2
Unit 7:		
Nano formulation and In vitro drug release study.	• List the applications of in-vitro drug release study (P1) • Construct a calibration curve for the drug release kinetics (P3) • Find the concentration of drug in the given solution (P1)	2
Unit 8:		
Synthesis of cadmium sulphide quantum dots in microemulsion.	• Define Quantum Dots (P1) • Make use of microemulsion method for the synthesis of CdS quantum dots (P3)	2

	• Explain the absorption spectrum (P2) • Find the diameter of the particle (P1)	
Unit 9:		
Synthesis of quantum dots using gel electrophoresis technique.	• Make use of agarose gel electrophoresis for the synthesis of cadmium sulphide nanoparticles (P3) • Summarise the principle of formation of nanoparticles in agarose matrix (P2) • Show the fluorescent bands under UV illuminator indicating the formation of nanoparticles (P2)	2
Unit 10:		
Synthesis of silver nanoparticles of variable size.	• Show the synthesize of a series of silver nanoparticles of varying sizes (P2) • Compare the variation of λmax with size of the nanoparticles (P2) • Relate the colours of the nanoparticles to its size (P2)	4
Unit 11:		
Synthesis of nanofibers using electrospinning	• Demonstration of the electrospinning equipment (P1) • Synthesis of the nanofibers using electrospinning (P2)	2

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	30	90
Revision		
Assessment	07	-
TOTAL	37	90

Assessment Methods:

Formative:	**Summative:**
Class tests	Sessional examination
Assignments/presentations	End semester examination
Quiz	

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4
Sessional Examination	x	x		
Quiz				
Assignment/Presentation	x	x	x	x
End Semester Examination				
Laboratory examination	x	x	x	x

Feedback Process	• End-Semester Feedback
Reference Material	• Edelstein AS, Cammarata RC. Nanomaterials: Synthesis, Properties and Applications Institute of Physics Publications, 1998

	• Cooke, J. Hebert, D. and Kelly, JA. Sweet Nanochemistry: A Fast, Reliable Alternative Synthesis of Yellow Colloidal Silver Nanoparticles Using Benign Reagents, J. Chem. Educ. 2015, 92, 2, 345-349. • Andrew J. Frank, AJ. Cathcart, N. Maly KE and Kitaev, V. Synthesis of Silver Nanoprisms with Variable Size and Investigation of Their Optical Properties: A First-Year Undergraduate Experiment Exploring Plasmonic Nanoparticles, J. Chem. Educ. 2010, 87, 10, 1098-1101.

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Seminar/Journal Club**
Course Code: BBT 319	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, V Semester**
No of Credits: 1	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course will include an allotment of an individual seminar topic related to the semester courses. This will enhance students' knowledge base and expose them to how to present information clearly and concisely. Students will also learn how to compile the literature database information.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react
CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks, and learn how to compile and interpret data.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×													
CO 4		×													
CO 5		×													
CO 6		×													

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual seminar topic related to the semester courses	30 minutes oral presentation for each student

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	15	45
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		

Practical		
Revision		
Assessment	01	-
TOTAL	**16**	**45**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the seminar topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Tutorials/Seminar/Journal Club**
Course Code: BBT 302	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: III Year, VI Semester**
No of Credits: 4	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course will include an allotment of an individual research topic. This will not only enhance the research knowledge base of students but also provide them exposure to how to present research information clearly and concisely. Students will also learn how to compile the research data.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react
CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define a problem in a concise manner
CO 6:	Adopt challenging tasks, and learn how to compile and interpret data.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×						×							
CO 4		×						×							
CO 5		×						×							
CO 6		×						×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*

Unit 1:		
Seminar	This course will include allotment of an individual research topic	30-minutes oral presentation for each student

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	60	180
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	01	-
TOTAL	**61**	**180**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	-

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the research topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Research Project Work**
Course Code: BBT 399	**Course Instructor: Supervisors**
Academic Year: 2023 Onwards	**Semester: III Year, VI Semester**
No of Credits: 16	**Prerequisites: Qualified previous semesters as per regulations**
Synopsis:	This course will include an allotment of individual research work for each student. This will enhance students' knowledge base and expose them to conducting and carrying out research-based tasks. Students will also learn how to compile and interpret results.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Define problems, formulate hypotheses, test hypotheses, analyse
CO 2:	Explain, problematize, synthesize, and articulate
CO 3:	Apply and draw conclusions from data, establish hypotheses, and predict cause-and-effect relationships;
CO 4:	Analyse cause-and-effect relationships
CO 5:	Define a problem in a concise manner
CO 6:	Adopt challenging tasks; students will also learn how to compile and interpret research data

Mapping of COs to POs															
COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1						×									
CO 2						×									
CO 3						×									
CO 4						×		×							
CO 5						×		×							
CO 6						×		×							

Course content and outcomes:		
Content	*Competencies*	*No of Hours*
Unit 1:		
Research Project	This course will include allotment of an individual research topic	26 hours of laboratory training and research per week

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	480	1440
Revision		
Assessment	01	-
TOTAL	**481**	**1440**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations/Manuscript submission	Project report submission/University Viva Voce Examination

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the research topics

Name of the Program:	**B Sc. Biotechnology (Honours)**
Course Title:	**Laboratory Rotation**

Course Code: BBT 401	**Course Instructor: Facility In-charge**
Academic Year: 2023 onwards	**Semester: IV Year, VII Semester**
No of Credits: 4	**Prerequisites Qualified previous semesters as per regulations with a CGPA of 7 and above**

Synopsis:	This course will include laboratory training in high-end facilities and high throughput data. This will enhance students' knowledge base and expose them to how to conduct and carry out research-based tasks.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Analyse different biological data
CO 2:	Explain, problematize, synthesize, and articulate
CO 3:	Apply and conclude the data
CO 4:	Analyse cause-and-effect relationships
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks, and students will also learn how to use facilities, compile and interpret research data

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1						×									
CO 2						×									
CO 3						×									
CO 4						×		×							
CO 5						×		×							
CO 6						×		×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Laboratory Rotation	This course will include hands-on training in various laboratory facilities and high-throughput data	8 hours of training per week

Learning strategies, contact hours, and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture		
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	120	360
Revision		
Assessment	1	-
TOTAL	**121**	**360**

Assessment Methods:

Formative:	**Summative:**
Report Submission	-

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA
Feedback Process	• End-Semester Feedback					
Reference Material	Reference Books and Journals articles related to the research topics					

Name of the Program:	**B. Sc. Biotechnology (Honours)**
Course Title:	**Tutorials/Seminar/Journal Club**
Course Code: BBT 403	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: IV Year, VII Semester**
No of Credits: 4	**Prerequisites: Qualified in previous semesters as per regulations with a CGPA of 7 and above**
Synopsis :	This course will include an allotment of an individual research topic. This will not only enhance the research knowledge base of students but also provide them exposure to how to present research information clearly and concisely. Students will also learn how to compile the research data.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react
CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define a problem in a concise manner
CO 6:	Adopt challenging tasks; students will also learn how to compile and interpret research data

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×						×							
CO 4		×						×							
CO 5		×						×							
CO 6		×						×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual research topic	30-minute

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	60	180
Small Group Discussion (SGD)		
Self-directed learning (SDL)		

Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	01	-
TOTAL	**61**	**180**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	-

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	X	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the research topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Research Project Work**
Course Code: BBT 405	**Course Instructor: Supervisor**
Academic Year: 2023 Onwards	**Semester: IV Year, VII Semester**
No of Credits: 12	**Prerequisites: Qualified in previous semesters as per regulations with a CGPA of 7 and above**
Synopsis:	This course will include an allotment of individual research work for each student. This will enhance students' knowledge base and expose them to how to conduct and carry out research-based tasks. Students will also learn how to compile and interpret results.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Analyse
CO 2:	Explain, problematize, synthesize, articulate
CO 3:	Apply and draw conclusions from data, establish hypotheses, and predict cause-and-effect relationships;
CO 4:	Analyse cause-and-effect relationships
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks, and learn how to compile and interpret data.

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1						×									
CO 2						×									
CO 3						×									
CO 4						×		×							
CO 5						×		×							

CO 6						×		×							

Course content and outcomes:		
Content	*Competencies*	*No of Hours*
Unit 1:		
Research Project	This course will include allotment of an individual research topic	26 hours of laboratory training and research per week

Learning strategies, contact hours and student learning time		
Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Practical	-	-
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	360	1080
Revision		
Assessment	01	-
TOTAL	**361**	**1080**

Assessment Methods:	
Formative:	**Summative:**
Assignments/presentations	Project report I submission and University Viva Voce Examination

Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	NA
Reference Material	Reference Books and Journals articles related to the research topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Tutorials/Seminar/Journal Club**
Course Code: BBT 402	**Course Instructor: Course In-charge**
Academic Year: 2023 onwards	**Semester: IV Year, VIII Semester**
No of Credits: 4	**Prerequisites: Qualified in previous semesters as per regulations**
Synopsis:	This course will include an allotment of an individual research topic. This will not only enhance the research knowledge base of students but also provide them exposure to how to present research information clearly and concisely. Students will also learn how to compile the research data.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express thoughts and ideas effectively
CO 2:	Demonstrate the ability to listen carefully and react

CO 3:	Apply one's views and present complex information clearly and concisely to different groups
CO 4:	Conclude on information
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks; students will also learn how to compile and interpret research data

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1		×													
CO 2		×													
CO 3		×						×							
CO 4		×						×							
CO 5		×						×							
CO 6		×						×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Seminar	This course will include allotment of an individual research topic	30 minutes oral presentation for each student

Learning strategies, contact hours and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar	60	180
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical		
Revision		
Assessment	01	-
TOTAL	**61**	**180**

Assessment Methods:

Formative:	**Summative:**
Assignments/presentations	-

Mapping of assessment with COs

Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	NA	NA	NA	NA	NA	NA
Laboratory examination	NA	NA	NA	NA	NA	NA

Feedback Process	• End-Semester Feedback
Reference Material	Reference Books and Journals articles related to the research topics

Name of the Program:	**B.Sc. Biotechnology (Honours)**
Course Title:	**Research Project Work**
Course Code: BBT 499	**Course Instructor: Supervisor**
Academic Year: 2023 onwards	**Semester: IV Year, VIII Semester**
No of Credits: 16	**Prerequisites: Qualified in previous semesters as per regulations**
Synopsis:	This course will include an allotment of individual research work for each student. This will enhance students' knowledge base and expose them to how to conduct and carry out research-based tasks. Students will also learn how to compile and interpret results.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Define problems, formulate hypotheses, test hypotheses, analyze,
CO 2:	Explain, problematize, synthesize, and articulate
CO 3:	Apply and draw conclusions from data, establish hypotheses, and predict cause-and-effect relationships;
CO 4:	Analyse cause-and-effect relationships
CO 5:	Define the problem in a concise manner
CO 6:	Adopt challenging tasks; students will also learn how to compile and interpret research data

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*	*PO 11*	*PO 12*	*PO 13*	*PO 14*	*PO 15*
CO 1						×									
CO 2						×									
CO 3						×									
CO 4						×		×							
CO 5						×		×							
CO 6						×		×							

Course content and outcomes:

Content	*Competencies*	*No of Hours*
Unit 1:		
Research Project	This course will include allotment of an individual research topic	26 hours of laboratory training and research per week

Learning strategies, contact hours, and student learning time

Learning strategy	*Contact hours*	*Student learning time (Hrs)*
Lecture	-	-
Seminar		
Small Group Discussion (SGD)		
Self-directed learning (SDL)		
Problem-Based Learning (PBL)		
Case Based Learning (CBL)		
Clinic		
Practical	480	1440
Revision		
Assessment	01	-
TOTAL	**481**	**1440**

Assessment Methods:	
Formative:	**Summative:**

Assignments/presentations/Manuscript submission					Dissertation submission and University Viva Voce Examination	
Mapping of assessment with COs						
Nature of assessment	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6
Sessional Examination	NA	NA	NA	NA		
Quiz	NA	NA	NA	NA	NA	NA
Assignment/Presentation	x	x	x	x	x	x
End Semester Examination	x	x	x	x	x	x
Laboratory examination	NA	NA	NA	NA	NA	NA
Feedback Process	• End-Semester Feedback					
Reference Material	Reference Books and Journals articles related to the research topics					

7. PROGAM OUTCOMES (POs) AND COURSE OUTCOMES (COs) MAPPING

Sl. No.	Course Code	Course Name	Credits	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
1	BBT 101	Basics of Biotechnology	3	CO1 to CO4		CO4		CO3										
2	BBT 103	Biology-I	3	CO1 to CO6		CO1 CO5		CO1 CO3										
3	BBT 105	Biology II	3	CO1 to CO6	CO1 to CO6		CO4						CO6					
4	BBT 107	Chemistry	3	CO1 to CO6			CO4 CO5											
5	BBT 109	Computer Science	3	CO1 to CO4		CO2	CO2		CO1		CO2 CO3		CO1 to CO4					
6	BBT 111	Biology I	1	CO1 to CO6					CO4				CO6					
7	BBT 113	Biology II	1	CO1 to CO6	CO1 to CO6		CO4						CO6					
8	BBT 115	Chemistry	1	CO1 to CO6			CO1 CO2 CO6				CO3 to CO6							
9	BBT 117	Computer Science	1	CO1 to CO4		CO2	CO2 CO4	CO2 CO4	CO4		CO4		CO1 to CO4					
10	BBT 119	Seminar/Journal Club	1		CO1 to CO6													
11	BBT 102	Cell biology	3	CO1 to CO6		CO2 to CO6												
12	BBT 104	Biochemistry	3	CO1 to CO6	CO1 to CO6	CO2 to CO6	CO3 CO6											
13	BBT 106	Environmental Science	3	CO1 to CO5			CO4 to CO5											
14	BBT 108	Physics	3	CO1 to CO6				CO4				CO5 CO6						
15	BBT 110	Advanced Chemistry	3	CO1 to CO6		CO6	CO1 CO3 CO6											
16	BBT 112	Cell Biology	2	CO1 to CO6	CO1 to CO5	CO3 CO5 CO6	CO1 to CO6	CO4	CO1 CO2 CO4 to CO6	CO 3	CO1 to CO6		CO5	CO4				
17	BBT 114	Biochemistry	2	CO1 to CO6					CO3 to CO6		CO1 to CO6							
18	BBT 116	Environmental Science	2	CO1 to CO6	CO1 to CO5	CO4	CO1 CO3 to CO6	CO2 CO3 CO5 CO6	CO1 CO6	CO2 CO4 CO6	CO1 to CO6	CO5	CO3	CO6	CO1 CO3	CO1 CO4 CO5	CO2 CO5	CO3

Sl. No.	Course Code	Course Name	Credits	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
19	BBT 118	Physics	1	CO1 to CO4 CO6				CO2 CO4 to CO6			CO1 to CO4							
20	BBT 120	Advanced Chemistry	1	CO1 to CO6	CO1 to CO6													
21	BBT 122	Seminar/Journal Club	1		CO1 to CO6													
22	BBT 201	Genetics	3	CO1 to CO6		CO1 to CO6	CO1 to CO4 CO6	CO2 CO3 CO6			CO2		CO6					
23	BBT 203	Molecular Biology	3	CO1 to CO6		CO3 CO5	CO1 CO2 CO4	CO3										
24	BBT 205	Microbiology	3	CO1 to CO6	CO1	CO1 to CO4 CO6		CO1 CO4	CO3 CO5 CO6		CO3 CO6							
25	BBT 207	Biophysics	3	CO1 to CO5	CO6			CO3 CO6				CO5						
26	BBT 209	Genetics	2	CO1 to CO6		CO1	CO1 CO3	CO3	CO4									
27	BBT 211	Molecular Biology	2	CO1 to CO5		CO1 CO3	CO2 CO3 CO5	CO1 CO2	CO1 CO4 CO5		CO1 to CO5							
28	BBT 213	Microbiology	2	CO1 to CO5		CO3 CO4 CO5		CO2 to CO5		CO1 CO2	CO3 to CO5							
29	BBT 215	Biophysics	1	CO1 to CO6			CO2 CO5 CO6	CO1 CO3	CO3	CO4	CO1 to CO4							
30	BBT 217	Seminar/Journal Club	1		CO1 to CO6													
31	BBT 202	Biostatistics	3	CO1 to CO5			CO6											
32	BBT 204	Pharmacology & Pharmacogenomics	3	CO1 to CO6		CO2 CO3 CO6		CO6	CO4									
33	BBT 206	Plant Biotechnology	3	CO1 to CO6	CO1 to CO6		CO4						CO6					
34	BBT 208	Bioinformatics	3	CO1 to CO5		CO2 CO3 CO5			CO2 CO3 CO5				CO2 to CO5					
35	BBT 210	Immunology	3	CO1 to CO6	CO1	CO1 to CO5		CO2 CO5	CO4 CO6		CO4							
36	BBT 212	Cell & Tissue Engineering	3	CO1 to CO6		CO3 CO5	CO1 CO2 CO4	CO3										

Sl. No.	Course Code	Course Name	Credits	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
37	BBT 214	Pharmacology & Pharmacogenomics	1	CO1 to CO6			CO4 CO5 CO6				CO4 CO5 CO6							
38	BBT 216	Plant Biotechnology	1	CO1 to CO6	CO1 to CO6		CO2 CO4	CO3	CO4		CO2		CO6		CO4	CO2 CO6	CO2	CO3 CO6
39	BBT 218	Bioinformatics	1	CO1 to CO5		CO1	CO3	CO2 CO4 CO5	CO2 CO4				CO1 to CO5					
40	BBT 220	Immunology	1	CO1 to CO6	CO1 CO2 CO4 CO5 CO6	CO1 CO4 CO5 CO6	CO1 to CO6	CO2 CO3	CO2 CO4 CO6		CO3 CO6							
41	BBT 222	Cell & Tissue Engineering	1	CO1 to CO5		CO1 CO3	CO2 CO3 CO5	CO1 CO2	CO1 CO4 CO5		CO1 to CO5							
42	BBT 224	Seminar/Journal Club	1		CO1 to CO6													
43	BBT 301	Microbial Biotechnology	3	CO1 to CO6		CO3 CO4	CO4	CO4			CO2		CO6					
44	BBT 303	Developmental Biology	3	CO1 to CO6		CO3 CO4 CO5	CO6	CO6			CO6	CO6						
45	BBT 305	Advanced Genomics	3	CO1 to CO5		CO3 CO5	CO1 CO2 CO4	CO3										
46	BBT 307	Nanobiotechnology	3	CO1 to CO6		CO4					CO5					CO6		
47	BBT 309	Research Methodology	3	CO1 to CO5	CO4	CO2 to CO5	CO3	CO1 to CO5	CO1 to CO5		CO3 CO4	CO1				CO5		
48	BBT 311	Microbial Biotechnology	1	CO1 to CO6		CO2 CO4 CO5		CO3 CO5		CO6	CO3 to CO6							
49	BBT 313	Developmental Biology	1	CO1 to CO4		CO1 to CO4		CO2 CO3 CO4			CO1 to CO4							
50	BBT 315	Advanced Genomics	1	CO1 to CO6		CO1 to CO6	CO1	CO6	CO2 to CO6		CO5 CO6							
51	BBT 317	Nanobiotechnology	1	CO1 to CO4		CO1		CO1 CO2	CO2		CO4					CO3		
52	BBT 319	Seminar/Journal Club	1		CO1 to CO6													
53	BBT 302	Tutorial/Seminars /Journal Club	4		CO1 to CO6						CO3 to CO6							
54	BBT 399	Research Project/ Submission of dissertation/ Submission of manuscript	16						CO1 to CO6		CO4 to CO6							

Sl. No.	Course Code	Course Name	Credits	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
55	BBT 401	Laboratory Rotation	4						CO1 to CO6		CO4 CO5 CO6							
56	BBT 403	Tutorials/Seminars/Journal Club	4		CO1 to CO6						CO3 to CO6							
57	BBT 405	Research Project work progress report I submission/ Presentation	12						CO1 to CO6		CO4 CO5 CO6							
58	BBT 402	Tutorials/Seminars/Journal Club	4		CO1 to CO6						CO3 to CO6							
59	BBT 499	Research Project work /Submission of manuscript	16						CO1 to CO6		CO4 CO5 CO6							