Final Syllabus: 09-12-25

Curriculum and Credit Framework for Undergraduate Programme

* Syllabus and Evaluation Scheme *

(In compliance with NEP-2020)

B.Sc. Hons. Biotechnology

(Semester I to VIII)

Department of Biotechnology
Faculty of Life Sciences
Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

(2025-26)

About the Biotechnology Department

The Department of Biotechnology, Chaudhary Bansi Lal University was established in year 2014 under the faculty of Life Sciences. The Department of Biotechnology offers programs at the undergraduate (B.Sc. Biotechnology), postgraduate (M.Sc. Biotechnology), and doctoral (Ph.D.) levels. The Department offers academic expertise and research skills in the field of biotechnology, with the aim of enhancing the entrepreneurial potential of its students.

The department's goal is to inspire students to excel in science and contribute to the betterment of society. The Department's educational environment provides an ideal platform for students' progress and enhances their association with skilled and devoted teaching faculty. It also combines classroom instruction with extracurricular activities that allow pupils to showcase their talents and grow as individuals. Furthermore, it is held accountable for the quality of its research and hands-on training provided to students in well-equipped laboratories. Students choose a research dissertation/study and perform research in a variety of biotechnology disciplines. The department invites famous scientists and academicians to deliver talks on current themes of national importance on a regular basis in order to keep students and faculty members up to date on recent achievements in the field of biotechnology. Students have qualified various National-level exams and are well-positioned in various institutions/industries. All faculty members conduct advanced research and have publications in prestigious international and national journals.

The department's mission is to produce Biotechnologists who are skilled in technology, creativity, innovation, and entrepreneurship. The Department of Biotechnology maintains illustrious standards of teaching and research with distinguished and dedicated faculty members. It encourages high-quality research in biotechnology/biological sciences for the benefit of society and humanity. The research focuses on malaria vector biology, immunology, parasitology, plant molecular signaling, plant stress biology, bioinformatics, computational drug design, bioremediation, plant-microbe interactions, and Nano-biotechnology.

1. Future Vision of the department

The Department strives to provide high-quality courses that include strong vocational elements and professional skill development across the curriculum. It also intends to train people in biotechnology-related fields such as Biological Chemistry, Molecular Biology, Genetic Engineering, Plant and Animal Biotechnology, Microbiology, developmental biology, bioinformatics, and bioprocess technology.

Biotechnology is a cutting-edge scientific field with enormous promise for human benefits. The Department will devote itself to establishing excellence in biotechnology promotion in the country. The Department will improve course content and practical facilities, as well as build the University's core lab facility, for the benefit of everyone. It will provide research services, encourage industries, and establish a centre of excellence. The Department would like to foster joint research projects by establishing Memoranda of Understanding (MOUs) with surrounding institutions, nationally/internationally. It also plans to run biotechnology-based programs for societal welfare. The Department also supports significant investment in the generation of products, processes, and technologies, as well as a strong infrastructure for research and commercialization; expanding the knowledge base, nurturing potential utility leads, and bringing bioproducts to market by promoting the biotech industry.

2. Objectives of the Department

- To ignite the mind of the new generation and create leadership qualities so that they can thrive in the realm of science.
- To provide academic knowledge and research abilities in the field of biotechnology.
- To foster entrepreneurial skills in order to drive societal growth and development.

3. Biotechnology curriculum development strategy

In anticipation of permission from the Academic Council/Executive Council, the Department of Biotechnology was established in the Faculty of Life Sciences in the year 2014. Initially, the State Government permitted Chaudhary Bansi Lal University, Bhiwani to accept the M.D. University, Rohtak's PG curriculum (as per letter no. 20/09-2014 UNP (1) dated nil from the Director General Higher Education, Haryana) until the same is framed by the University. The issue was settled at the first meeting of the Executive Council on May 05, 2015 and the M.D. University, Rohtak syllabus was implemented in the Department of Biotechnology as such. Following that, the Adhoc Postgraduate Board of Studies was formed at the fourth meeting of the Executive Council on July 25, 2015, to modify the syllabi from the session 2015-16. During the Academic Session 2015-16, University implemented the *Choice Based Credit System* (CBCS). In the Academic Council meeting on December 3, 2018, almost half of the department's syllabus was revised and approved. The entire course was revised and approved by the Academic Council on August 14, 2019. New courses were added, while current courses were revised after two years, and over 20% of the syllabus was updated (as per Haryana State Higher Education Council letter no. 1/20-2020 ADV-HSHEC, 26-05-2020) and accepted in the Academic Council on October 6, 2020. In the year 2022, two more adjustments were made: the syllabus of the communication skills course was entirely revised, and the hobby club structure and syllabi were modified. In year 2023 and 2025, respectively the syllabus was further revised in accordance with NEP2020. The curriculum for UG is implemented for the first time in the department during session 2025-26.

Thus, curriculum planning, design, development, and implementation based on local, national, regional, and global demands are critical to the department's teaching and knowledge-providing processes. It is part of the department's ongoing methodical approach.

4. Curriculum development and implementation

The concept of launching a new Program/course is conceived at the departmental level, followed by a feasibility study after consulting with various stakeholders such as students, alumni, faculty, industry experts, and academic quality regulatory bodies such as UGC and DHE. The Department's proposed curriculum is presented to the Post Graduate Board of Studies for additional consideration in the presence of two domain experts, one industry professional, and one alumni member. The Board of Studies proposes the syllabus to the relevant faculty, who then forward it to the Academic Council. Any deficiencies/suggestions in the curriculum are forwarded to lower academic bodies for further improvement. The University modifies the curricula of its various programmes in response to national/international developments and industry demand.

Students gain a strong theoretical foundation as well as the required skills and techniques in biological sciences and they are able to apply these tools in the industry, healthcare, community, institutes, or other professions that they desire to follow. Given global scientific breakthroughs in the field of biotechnology, it was highly desirable to update and modify the current course to fulfill the goals of both research and industry. Some of the more prominent components of the Department of Biotechnology's curriculum are as follows:

a. The curriculum adheres to UGC requirements, giving students more options from intra-disciplinary (Core and Elective) and inter-disciplinary (Open Electives). In response to national/international advancements and industry demand, the University adjusts the curricula of its numerous programmes.

b. After completing a degree in Biotechnology, the student is expected to enter the employment market as a trained biotechnologist wherever needed in academia and industry or to launch and develop a start-up into a commercial enterprise.

c. The programme is organized such that students are introduced to the essential foundation courses in the first semester. Core Courses are required to be studied by a student in order to complete the

requirements of a programme. Overall skills enhancement course are also included, specifically to familiarize students with good personality traits.

d. Following that, as a basic element of the programme, they are required to learn the advance courses as well as skill enhancement courses. Students are also encouraged to select elective courses from a pool or MOOC courses to enhance their knowledge. Students are also permitted to select any one course from the University's open electives that are floated by the other teaching departments.

e. Research is also included where students are required to perform the research on selected topic that exposes them to the topic of choice in research. Students are offered some of the industry- and entrepreneur-oriented courses to excel in these areas.

f. Entrepreneurship classes introduce pupils to the concepts such as recognizing a winning business opportunity, obtaining money and launching a business, growing and nurturing the organization, and reaping the benefits.

g. Students are motivated to adopt MOOC courses through SWAYAM or any other relevant portal to earn extra credits, according to MHRD requirements, from the existing MOOC courses. In case of addition of other new courses to SWAYAM platform can also be adopted. The procedure for taking MOOC course will be in consultation with the MOOC Coordinator of the department.

Biotechnologists are in high demand in a wide range of industries and sectors, including agriculture, animal husbandry, environmental conservation, ecology, genetic engineering, healthcare, pharmaceutical, medicine, academia, industrial research, and development. The department strongly believes that the current curriculum is at par to the modern demands of society and industry.

5. Program learning outcomes (PLOs)

The students on completion of the Bachelor's programme will be able to:-

PLO 1: Demonstrate advanced knowledge about biotechnology with a critical understanding of the emerging developments and issues relating to the learner's domain area.

PLO 2: Demonstrate advanced knowledge and understanding of principles, methods, and techniques applicable to the chosen field of study.

PLO 3: Demonstrate the capacity to extrapolate the acquired knowledge and skills to real-life situations and apply acquired competencies in new/unfamiliar contexts.

PLO 4: Demonstrate the ability to apply the acquired conceptual, operational, or technical knowledge and a range of cognitive and practical skills to identify and address problems related to the chosen field of learning.

PLO 5: Demonstrate advanced knowledge relating to research methods to carry out research and investigations to formulate evidence-based solutions to complex and unpredictable problems in the field of biotechnology.

PLO 6: Demonstrate the ability to communicate, in a well-structured manner, the findings/results of the research studies undertaken in the field of biotechnology.

PLO 7: Pursue self-paced and self-directed learning to upgrade knowledge and skills, including research-related skills, while avoiding unethical practices.

Course mapping with PLO for PG Programme

Course code	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
25UN-BIT-101	√	√	√	√	√	√	√
25UN-BIT-102	√	√	√	√	√	√	√
25UN-BIT-103	√	√	√	√	√	√	√
25UN-BIT-201	√	√	√	√	√	√	√
25UN-BIT-202	√	√	√	√	√	√	√
25UN-BIT-203	√	√	√	√	√	√	√
25UN-BIT-301	√	√	√	√	√	√	√
25UN-BIT-302	√	√	√	√	√	√	√
25UN-BIT-303	√	√	√	√	√	√	√
25UN-BIT-401	√	√	√	√	√	√	√
25UN-BIT-402	√	√	√	√	√	√	√
25UN-BIT-403	√	√	√	√	√	√	√
25UN-BIT-404	√	√	√	√	√	√	√
25UN-BIT-405	√	√	√	√	X	√	√
25UN-BIT-501	√	√	√	√	√	√	√
25UN-BIT-502	√	√	√	√	√	√	√
25UN-BIT-503	√	√	√	√	√	√	√
25UN-BIT-504	√	√	√	√	√	√	√
25UN-BIT-505	√	√	√	√	√	√	√
25UN-BIT-506	√	√	√	X	X	√	√
25UN-BIT-507	√	√	√	√	√	√	√
25UN-BIT-508	√	√	√	√	√	√	√
25UN-BIT-509	√	√	√	X	√	√	√
25UN-BIT-601	√	√	√	√	√	√	√
25UN-BIT-602	√	√	√	√	√	√	√
25UN-BIT-603	√	√	√	√	√	√	√
25UN-BIT-604	√	√	√	√	√	√	√
25UN-BIT-605	√	√	√	√	√	√	√
25UN-BIT-606	√	√	√	√	√	√	√
25UN-BIT-607	√	√	√	√	√	√	√
25UN-BIT-608	√	√	√	√	√	√	√

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B.Sc. Biotechnology Evaluation Scheme

Summary

Program	:	**B.Sc. Biotechnology**
Duration	:	Four years (Eight Semesters)
Minimum Attendance Required	:	**75% Mandatory**
Total Credits	:	**184***

* Exit might be taken by student as per the University ordinance.

Assessment/Evaluation of Theory examination:

Course Credit		Theory		Practical		Total
Theory	Practical	Internal Assessment Marks	End-Term Exam Marks	Internal Assessment Marks	End-Term Exam Marks	Marks
1	1	10	20	5	15	50
2	1	15	35	5	15	70
3	1	20	50	10	20	100
2	2	15	35	15	35	100
0	4	—	—	30	70	100
4	0	—	—	30	70	100

Internal Evaluation Theory:

Total Internal Assessment Marks (Theory)	Class Participation	Seminar/Presentation/ Assignment/Quiz/Class Test, etc.	Mid-Term Exam
10	4	-	6
15	4	4	7
20	5	5	10
30	5	10	15

Duration of Examination:

Minor Test	Major Test (End Semester Exam)
1 to 1.5 h	2 to 3 h

To qualify for the course, a student is required to secure a minimum of 40% marks in aggregate including the internal evaluation and Major Test (End Semester Examination).

Education/Teaching policies and Assessments: Lectures will be delivered using livelihood methods wherever required to the subject concerned. The syllabus will be covered by different modes such as, Digital aided learning (DAL), Digital and classroom learning (DCL), classroom and lab learning (CLL), and Digital self-learning (DSL). The blending of the curriculum with the Indian knowledge system has also been considered while designing the curriculum. Students are advised to take the MOOC courses or related online courses from the SWAYAM portal as per UGC guidelines or other sources in any semester.

The NEP 2020 emphasizes upon formative and continuous assessment rather than summative

assessment. Therefore, the scheme of assessment should have components of these two types of assessments. Assessment should have correlations with the learning outcomes that are achieved by a student after completion of the course. The process of assessment is dealt by the Ordinance for UG Programs and suggested to include quizzes, assignments, declamation, debate and discussion, problems based on the real situation, oral presentation and viva, publication, theoretical/experimental design, internal and external examination, and not limited to.

Semester-III Credits-22 Marks-540

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	25UN-BIT-301	Fundamental Biological Chemistry	CC4	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
2	25UN-BIT-302	Recombinant DNA Technology	CC5	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
3	25UN-BIT-303	Industrial Microbiology	CCM3	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
4	*	Available MDC	MDC3	3	-	3	3	-	3	50	20	-	70
5		Available AEC	AEC3	2	-	2	2	-	2	35	15	-	50
6		Available SEC	SEC3	3	-	3	3	-	3	50	20	-	70
7		Available VAC	VAC3	2	-	2	2	-	2	35	15	-	50
		Total		**19**	**6**	**25**	**19**	**3**	**22**	**320**	**130**	**90**	**540**

CC: Core Course, **CCM:** Core Course Minor, **MDC:** Multidisciplinary Course, **AEC:** Ability Enhancement Course, **SEC:** Skill Enhancement Course, **VAC:** Value Added Course

* Student will select a particular course of choice from the list provided or as offered by the university

Semester- IV Credits-24 Marks-600

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	25UN-BIT-401	Immunology	CC6	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
2	25UN-BIT-402	Introductory Bioinformatics	CC7	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
3	25UN-BIT-403	Food Biotechnology	CC8	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
4	25UN-BIT-404	Medical Microbiology	CCM4 (V)	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
5	25UN-BIT-405	Introduction to IPR	DSE1	4	-	4	4	-	4	70	30	-	100
6	*	Available AEC	AEC4	2	-	2	2	-	2	35	15	-	50
7		Available VAC	VAC4	2	-	2	2	-	2	35	15	-	50
		Total		**20**	**8**	**28**	**20**	**4**	**24**	**340**	**140**	**120**	**600**

CC: Core Course, **DSE:** Discipline Specific Elective, **CCM(V):** Core Course Minor (Vocational), **AEC:** Ability Enhancement Course, **VAC:** Value Added Course

* Student will select the particular course of choice from the list provided or as offered by the university

Students who exit after 2 years should undergo an internship (4 credits) to receive a UG Diploma in Biotech.

Semester-V Credits-20 Marks-500

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	25UN-BIT-501	Biostatistics	CC9	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
2	25UN-BIT-502	Introductory Biotechniques	CC10	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
3	25UN-BIT-503	Fundamentals of Enzymology	DSE2 and DSE3 (Select **any two**)	4	-	4	4	-	4	70	30	-	100
4	25UN-BIT-504	Cell and Tissue Culture											
5	25UN-BIT-505	Foundations of Environment and Ecology											
6	25UN-BIT-506	Foundations of Nanobiotechnology											
7	25UN-BIT-507	Pharmaceutical Biotechnology											
8	25UN-BIT-508	Molecular Medicine											
9	25UN-BIT-509	Viruses and Diseases	CCM5 (V)	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
		Total		**17**	**6**	**23**	**17**	**3**	**20**	**290**	**120**	**90**	**500**

CC: Core Course, **DSE:** Discipline Specific Elective, **CCM(V):** Core Course Minor (Vocational),

Semester-VI Credits-22 Marks-550

SN	Paper Code	Subject	Course Type	Weekly contact hour			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	25UN-BIT-601	Genomics and Proteomics	CC11	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
2	25UN-BIT-602	Genetics and Developmental Biology	CC12	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
3	25UN-BIT-603	Biotechnology and Food Security	DSE4 and DSC5 (**any two**)	4	-	4	4	-	4	70	30	-	100
4	25UN-BIT-604	Bioentrepreneurship											
5	25UN-BIT-605	Biotechnology of Vaccines											
6	25UN-BIT-606	Biotechnology for Sustainable Development											
7	25UN-BIT-607	Diagnostic Laboratory Techniques											
8	25UN-BIT-608	Microbial Genetics	CCM6 (V)	3	-	3	3	-	3	50	20	-	70
		Practical		-	2	2	-	1	1	-	-	30	30
9	*	Available SEC	SEC4	2	-	2	2	-	2	35	15	-	50
		Total		**19**	**6**	**25**	**19**	**3**	**22**	**325**	**135**	**90**	**550**

CC: Core Course, **DSE:** Discipline Specific Elective, **CCM(V):** Core Course Minor (Vocational), **SEC:** Skill Enhancement Course

* Student will select the particular course of choice from the list provided or as offered by the university

Students who exit after 3 years should undergo an internship (4 credits) to receive a UG degree certificate in Biotech. The internship can be completed anytime after 1, 2 or 3 years for UG degree in Biotech.

25UN-BIT-301 Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Fundamental Biological Chemistry Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with a foundational understanding of chemistry principles relevant to biological systems, including chemical reactions, energy changes, chemical bonding, states of matter, acids, bases, buffers, and organic reactions. To develop practical skills in preparing chemical solutions and conducting experiments with safety protocols.

Course Outcomes:
CO1: Explain the fundamental principles of chemistry relevant to biological systems.
CO2: Describe chemical reactions, stoichiometry, and energy changes (e.g., free energy, entropy) in biological contexts.
CO3: Analyze chemical bonding, states of matter, acids, bases, buffers, and their roles in biological systems.
CO4: Explain isomerism, redox reactions, and their significance in biological molecules and processes.
CO5: Perform experiments involving preparation of chemical solutions & stocks, adhering to laboratory safety protocols.

Unit I

Introduction to Biological Chemistry: Overview of biological chemistry, including its role in understanding life processes; basic chemical concepts, pH, and buffers; importance of water as a biological solvent; Polar and non-polar substances. Concept of Bioenergetics, biological oxidation-reduction, and components involved in electron transport, Phosphoryl group transfer reactions.

Unit II

Chemical reactions and energy: Introduction to metabolism, including catabolism and anabolism; Chemical reactions, reaction stoichiometry, order of reactions, Arrhenius equation, rate-determining steps, catalysis, free-energy, entropy, and enthalpy changes during reactions. Metabolic processes in energy production and storage.

Unit III

Chemical bondings and Biochemical Reactions: Chemical bonds (ionic, covalent, hydrogen), and Van der Waals forces. Ionic product of water, weak acids and bases, conjugate acid-base pairs Reactivity of carbohydrates in energy metabolism; role of lipids in membrane formation & energy storage; protein structure & function in enzymatic reactions.

Unit IV

Concept of isomerism and Applications of Biological Chemistry: Types of isomerism, Optical isomerism, chiral and achiral molecules. Configuration of geometric isomers. Cis-Trans nomenclature. Applications of biological chemistry in biotechnology, production of biofuels and pharmaceuticals. Enzyme-based tests for diseases.

Suggested Readings:
1. Lehninger Principles of Biochemistry by Nelson, D. L., & Cox, M. M. W.H. Freeman.
2. Biochemistry: The Molecular Basis of Life by McKee, T., & McKee, J. R.Oxford University Press.
3. Biochemistry by Campbell, M. K., & Farrell, S. O. Cengage Learning.
4. Outlines of Biochemistry by E.E. Conn, P.K. Stumpf, G. Bruening, and Ray H. Doi, John Wiley.
5. General Chemistry. Ebbing, D.D., & Wrighton, M.S. Boston: Houghton Mifflin.
6. Chemistry: Principles, Patterns, and Applications. Averill, B., & Eldredge, P. San Francisco: Benjamin Cummings
7. University Chemistry. Mahan, B.H. Reading, MA: Addison-Wesley Pub.
8. Biophysical Chemistry. Cantor, C.R., & Schimmel, P.R. San Francisco: W.H. Freeman.
Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Preparation and testing of buffer solutions for pH stability.
2. Qualitative analysis of glucose using Fehling's test.
3. Assay of enzyme activity (e.g., catalase) using a simple titration method.
4. Extraction and detection of lipids from seeds using solvent extraction.
5. Measurement of protein concentration using a colorimetric assay.
6. Observation of metabolic reactions using yeast fermentation.
7. Analysis of biomolecules using thin-layer chromatography.
8. Study of enzyme kinetics with varying substrate concentrations.

25UN-BIT-302
Recombinant DNA Technology

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To introduce students to the principles and techniques of genetic engineering, focusing on recombinant DNA technology, gene cloning, PCR, and their applications in various biotechnological fields. To provide practical training in nucleic acid manipulation and cloning techniques.

Course Outcomes:
CO1: Explain the principles and scope of recombinant DNA technology in biotechnology.
CO2: Describe methodologies for nucleic acid isolation, purification, gene cloning, transformation, and clone selection.
CO3: Understand the concepts and methodology of PCR and its uses in diverse fields of life sciences.
CO4: Apply genetic engineering techniques in microbial, plant, animal, environmental, and health biotechnology.

Unit I

Recombinant DNA (rDNA) technology: Introduction and scope of rDNA technology, Milestones in Genetic engineering, Central role of *E. coli* in genetic engineering. Nucleic Acids: Purification of total cell DNA, plasmid DNA, phage DNA, Yield Analysis. Southern blotting and Northern blotting.

Unit II

Gene Modifying Enzymes: Importance of DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases, Terminal deoxynucleotidyl transferase, Reverse transcriptase, Ligases, and Restriction endonucleases. Restriction endonucleases, nomenclature, types, blunt and sticky ends cutters. Linkers and adaptors.

Unit III

Gene Cloning Vectors: General features, Types of cloning vectors - Plasmid, bacteriophage, phagemid, cosmid. Construction of recombinant DNA, Preparation of competent cells, Gene transfer using plasmids and other cloning vectors. Other techniques of gene transfer: Microinjection and Electroporation.

Unit IV

Gene Recombination and Gene transfer: Cloning and Subcloning Strategy, Transformation, Transfection. Selection and Screening of Recombinants (bacteria and phages); Cloning strategies in *E. coli*. Cloning of Specific Gene: Genomic and cDNA library. Applications of rDNA technology.

Suggested Readings:

1. Biotechnology: Expanding Horizon. Singh B.D. Kalyani Publishers.
2. Biotechnology and Genomics. Gupta P.K. Rastogi Publishers.
3. Applying Genetic Revolution. Clark D.V. and Pazdernik, N.J. Academic Press.
4. Gene Cloning and DNA Analysis – An Introduction, T.A. Brown, Blackwell Publisher.
5. Essential Genes, Benjamin Lewin, Pearson Education International.
6. Genome-3 by T.A. Brown. Garland Science, Taylor & Francis, New York.
7. Principles of Gene Manipulation and Genomics, S.B. Primrose and R.M. Twyman, Blackwell Publishing.
8. Principles of Genetic Engineering, Mousumi Debnath, Pointer Publisher, Jaipur.
9. Molecular Biotechnology - Principles and Applications of Recombinant DNA.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:

1. Extraction of genomic DNA from bacterial cells (e.g., *E. coli*) using a simple lysis method.
2. Amplification of a DNA fragment using polymerase chain reaction (PCR).
3. Analysis of PCR products by agarose gel electrophoresis with a safe dye.
4. Restriction enzyme digestion of plasmid DNA and visualization on gel.
5. Bacterial transformation with a plasmid containing a reporter gene (e.g., GFP).
6. Preparation of competent bacterial cells for transformation.
7. Simulation of gene cloning using online tools (e.g., SnapGene or Benchling).
8. Analysis of a recombinant DNA construct using restriction mapping.

B.Sc. Biotechnology (Semester III)

25UN-BIT-303
Industrial Microbiology

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course aims to introduce students to the principles of industrial microbiology by exploring the role of microorganisms like bacteria, fungi, and yeast in industrial processes, explain the production of primary and secondary metabolites such as ethanol and antibiotics through fermentation, provide hands-on experience in basic fermentation techniques and microbial culturing for optimizing industrial yields, and highlight its applications.

Course Outcomes:
CO1: Describe the role of microbes in industrial biotechnology.
CO2: Learn basic fermentation and culturing techniques for industrial applications.
CO3: Explain the production processes of microbial products like antibiotics and biofuels.
CO4: Describe the economic and environmental impacts of industrial microbiology.

Unit I

Introduction to Industrial Microbiology: Overview of industrial microbiology, including its scope and importance; types of microorganisms used in industry, such as bacteria, fungi, and yeast; industrial fermentation processes, including batch and continuous fermentation; examples of industrial microbial products, like antibiotics and ethanol.

Unit II

Microbial Production of Metabolites: Primary metabolites, such as ethanol and organic acids, and their production; secondary metabolites, such as antibiotics (e.g., penicillin) and their biosynthesis; role of microbes in enzyme production, like amylases and proteases; optimization of microbial growth for industrial yield.

Unit III

Fermentation Technology: Components of a fermenter, including design and operation; fermentation conditions, such as pH, temperature, and aeration; downstream processing, including product recovery and purification; case studies on industrial fermentation, like citric acid production.

Unit IV

Applications and Challenges: Applications of industrial microbiology in pharmaceuticals, food, and biofuel industries; environmental applications, such as bioremediation and waste treatment; economic considerations, including cost and scalability; challenges, such as contamination and regulatory compliance.

Suggested Readings:

1. Industrial Microbiology: An Introduction. Waites, M. J., Morgan, N. L., Rockey, JS., & Higton, G. Blackwell Science.
2. Principles of Fermentation Technology. Stanbury, P. F., Whitaker, A., & Hall, S. J. Pergamon Press.
3. Biotechnology: A Textbook of Industrial Microbiology. Crueger, W., & Crueger, A. Sinauer Associates.
4. Principles of Fermentation Technology, Stanbury P.F. et al., Pergamon Press, Oxford.
5. Fermentation Biotechnology – Principles, Process and Products, Ward O.P., Prentice Hall Publishing, New Jersey.
6. Microbial Biotechnology: Basic Research and Applications, Edited by Singh et al., Springer.
7. Modern Industrial Microbiology and Biotechnology, Nduka Okafor, Science Publishers.
8. Manual of Industrial Microbiology and Biotechnology, Arnold I. Demain and Julian E. Davies, ASM Press.
9. Microbial Biotechnology, Glazer and Nikaido, WH Freeman & Company, New York.
10. Biotechnology – A Textbook of Industrial Microbiology, Cruger and Cruger, Panima Publishing Corporation.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Isolation of industrially important microbes (e.g., *Saccharomyces*) from environmental samples.
2. Preparation of nutrient agar and broth for microbial culture.
3. Fermentation experiment to produce ethanol using yeast.
4. Assay of amylase production by Bacillus species.
5. Optimization of microbial growth conditions (e.g., pH or temperature).
6. Analysis of fermentation products using simple biochemical tests.
7. Demonstration of a benchtop fermenter and its components.
8. Study of antibiotic production by Streptomyces using agar diffusion assay.

25UN-BIT-401
Immunology

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of the immune system's components, mechanisms, and interactions, including innate and adaptive immunity, antigen-antibody interactions, and immune responses. To develop practical skills in immunological assays and techniques such as ELISA, immunodiffusion, and blood typing.

Course Outcomes:
CO1: Explain the coordination of innate and adaptive immune responses in combating pathogens.
CO2: Describe the structure, function, and interactions of antigens and antibodies.
CO3: Analyze the principles of immune cell responses, including B- & T-cell receptor functions and MHC interactions.
CO4: Evaluate immune-related health issues, including hypersensitivity, autoimmune disorders, and vaccine types.
CO5: Learning immunological assays such as ELISA and double immunodiffusion (DID).

Unit I

Introduction and overview: Preface of immunology, cells and organs of immune system. Primary and secondary responses. Innate immunity: anatomic, physiological, phagocytic, and inflammatory barriers. Adaptive immunity: Humoral and cell-mediated. Interrelationship between innate and acquired immunity.

Unit II

Antigens: Concept of antigenicity and immunogenicity, Antigens, epitopes, haptens, and adjuvants. Antibodies: basic structure of antibodies, antibody classes and their biological activity, immunoglobulin super family, antigen-antibody interactions: immunoprecipitation, agglutination.

Unit III

Basic principles of immune system: Structure and function of T-cell receptor. Structure and role of Major Histocompatibility Complex. Introduction of antigen processing and presentation. Complement system. Cytokines & their roles.

Unit IV

Immune system in health and disease: Hypersensitivity reactions-their types and mechanism, Autoimmune disorders. Hybridoma technology: production of monoclonal antibodies. Passive and active immunization. Live attenuated and DNA vaccines.

Suggested readings:

1. Immunology by Kuby J. W.H. Freeman & Co., New York.
2. Cellular and Molecular Immunology by Abul K Abbas et al., Elsevier, Inc.
3. Immunology: A Short Course by Coico, Richard and Sunshine, Geoffrey. Willey-Blackwell Press.
4. Essential Immunology by Roitt, I.M. Oxford Black Well Science, London.
5. Immunology by Raj Khanna, Oxford Press.
6. Immunology and Immunotechnology by Chakravarty AK, Oxford press.
7. The Elements of Immunology by Fahim Halim Khan, Pearson Education

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:

1. Preparation of blood smears to observe white blood cells under a microscope.
2. Differential staining of blood cells to identify leukocytes.
3. Demonstration of agglutination reactions using simulated antigen-antibody interactions.
4. Perform a simple ELISA to detect a mock antigen or antibody.
5. Observation of immune cells (e.g., lymphocytes) using pre-prepared slides.
6. Analysis of blood group typing using antisera (simulated or safe kits).
7. Study of phagocytosis using yeast cells stained with Congo red.
8. Case study analysis of immune response using vaccine-related data.

25UN-BIT-402 Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Introductory Bioinformatics Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course provides a comprehensive understanding of bioinformatics, its foundational concepts, tools, and applications in modern biological research. Students develop familiarity with key biological databases, data types, and online bioinformatics resources including the NCBI platform. It will provide knowledge and insights necessary to apply bioinformatics tools and methods in biological data analysis and research.

Course Outcomes:
CO1: Understand the basic principles and concepts of bioinformatics.
CO2: Conceptualize the application of bioinformatics tools to solve biological problems.
CO3: Critically evaluate bioinformatics research papers and studies.
CO4: Understand various databases available to support further research in biology.
CO5: Develop skills in navigating databases, performing searches, and interpreting biological data for research.

Unit I

Overview of bioinformatics: History, scope, and detailed applications. Introduction to biological databases and data types, Bioinformatics resources and tools, Detailed Overview of NCBI Homepage. Virtual library.

Unit II

Biomolecules in bioinformatics: Biomolecules studied in Bioinformatics (polynucleotide, polypeptides, Gene, Protein). Format of Sequence databases, Introduction to Pairwise Sequence Analysis and Sequence alignment, Introduction and applications of Multiple sequence alignment.

Unit III

Basics of Bioinformatics: Introduction to the following: In silico drug design, Genomics, proteomics, transcriptomics, metabolomics, chemoinformatics, pharmacogenomics.

Unit IV

Techniques: Introduction to various biological techniques required for Bioinformatic analysis (DNA, RNA, Protein - isolation and sequencing, etc.). Human Genome Project objectives and applications.

Suggested readings:

1. Essential Bioinformatics by Jin Xiong, Cambridge publisher.
2. Bionformatics: Principles and Applications) by Zhumur Ghosh and Bibekanand Mallick, Oxford University Press.
3. Bioinformatics by Orpita Bosu and Simminder Kaur Thukral, Oxford University Press publisher
4. Introduction to Bioinformatics by M Lesk, Oxford University Press publisher.
5. Fundamental Concepts of Bioinformatics by Dan E Krane, Michael L Raymer, Michaeel L Raymer, Elaine Nicpon Marieb, Benjamin/Cummings.
6. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by P Rastogi and N Mendiritta, Prentice-Hall of India Pvt. Ltd.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:

1. Sequence retrieval from a genomic database (e.g., NCBI) for a specific gene.
2. Pairwise sequence alignment using BLAST to compare DNA sequences.
3. Construction of a phylogenetic tree using simple software (e.g., MEGA).
4. Analysis of protein structure using online tools (e.g., PyMOL or Swiss-PDB Viewer).
5. Simulation of primer design for PCR using bioinformatics software.
6. Study of gene annotation using a genome browser (e.g., Ensembl).
7. Comparison of DNA sequences from different organisms using online tools.
8. Case study on bioinformatics applications in identifying disease-related genes.

25UN-BIT-403
Food Biotechnology

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course aims to introduce students to the principles and techniques of food biotechnology, explore the role of biotechnology in improving food production and safety, develop practical skills in microbial and enzymatic processes for food processing, and highlight the ethical and regulatory aspects of food biotechnology.

Course Outcomes:
CO1: Describe the role of biotechnology in food production and processing.
CO2: Learn microbial and enzymatic techniques used in food biotechnology.
CO3: Explain the applications of biotechnology in improving food quality and safety.
CO4: Describe ethical and regulatory issues in food biotechnology.

Unit I

Introduction to Food Biotechnology: Overview of food biotechnology, including its history and importance in food security; role of microorganisms in food production, such as fermentation; biotechnological techniques, including genetic modification and enzyme technology; examples of biotech foods, like GM crops and fermented products.

Unit II

Microbial Fermentation in Food Production: Role of microbes in fermentation, including bacteria (e.g., Lactobacillus) and yeast (e.g., Saccharomyces); fermented foods, such as yogurt, cheese, and bread; microbial processes for flavor, texture, and preservation; introduction to starter cultures and their maintenance.

Unit III

Genetic Modification and Food Safety: Genetic engineering of crops for improved yield, pest resistance, and nutritional content; examples of GM foods, such as Bt corn and Golden Rice; biotechnological methods for food safety, including detection of pathogens and toxins; role of enzymes in food processing, like amylases and proteases.

Unit IV

Ethical and Regulatory Considerations: Ethical issues in food biotechnology, including consumer acceptance and environmental impact; regulatory frameworks for GM foods, such as Codex Alimentarius and national guidelines; safety assessment of biotech foods; future trends, including plant-based proteins and lab-grown foods.

Suggested Readings:

1. Transgenics and the Poor: Biotechnology in Development Studies. Herring, R. J. Routledge.
2. Food Security: Policy and Challenges. Pinstrup-Andersen, P. Cornell University Press.
3. Genetically Modified Crops and Agricultural Development. Qaim, M. Palgrave Macmillan.
4. Food Biotechnology. Bielecki, S., Tramper, J., & Polak, J. Elsevier.
5. Food Biotechnology. Shetty, K., Paliyath, G., Pometto, A., & Levin, R. E. CRC Press.
6. Modern Biotechnology: Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals. Mosier, N. S., & Ladisch, M. R. Wiley.
7. Articles from Trends in Food Science & Technology and Journal of Food Biotechnology.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:

1. Preparation of yogurt using Lactobacillus cultures.
2. Fermentation of bread dough using yeast and observation of CO_2 production.
3. Detection of microbial contamination in food samples using plating techniques.
4. Analysis of enzyme activity (e.g., amylase) in food processing.
5. Preparation of a fruit-based fermented beverage (e.g., kombucha).
6. Extraction and analysis of starch from plant material.
7. Study of GM food labeling using a case study approach.
8. Observation of microbial growth in food samples under different storage conditions.

25UN-BIT-404 Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Medical Microbiology Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of the principles of medical microbiology, mechanisms of disease transmission, and the role of pathogenic microorganisms in human diseases. To develop practical skills in microbial culturing, biosafety techniques, and antibiotic sensitivity testing.

Course Outcomes:
CO1: Explain the principles of medical microbiology and mechanisms of infectious disease transmission.
CO2: Analyze the role of pathogenic microorganisms in human diseases.
CO3: Describe the morphology, pathogenesis, diagnosis, prevention, and treatment of microbial infections.
CO4: Provide the knowledge of microbial culturing, biosafety procedures, and antibiotic sensitivity testing.

Unit I

Introduction: History & developments of medical microbiology, introduction to bacteriology, mycology, virology, and parasitology. Definition, Importance, Principle, Operation, and Applications of microscopy. Sterilization and Disinfection: Introduction and its types, principle, procedure, & its application, biosafety in microbiology lab.

Unit II

Chemotherapeutic agents: Introduction, types of chemotherapeutic agents, mode of action, and clinical importance of different chemotherapeutic agents, antibiotic sensitivity tests, and its medical importance, multiple drug resistance, and mechanism of drug resistance. Normal microbial flora of the human body, collection and transport of specimens, processing of clinical specimens for microbiological examination.

Unit III

Microbial diseases: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, of gram-positive bacteria (*S. aureus*, *B. anthracis*, *C. tetani*, *C. diphtheriae*, *M. tuberculosis*) and gram-negative bacteria (*E. coli*, *N. meningitidis*, *S. typhi*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*), viruses, rickettsia, and fungi.

Unit IV

Diagnosis and therapy: Laboratory diagnosis, preventive measures, chemotherapy, and vaccination against the diseases caused by gram-positive bacteria gram-positive bacteria (*S. aureus*, *B. anthracis*, *C. tetani*, *C. diphtheriae*, *M. tuberculosis*) and gram-negative bacteria (*E. coli*, *N. meningitidis*, *S. typhi*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*), viruses, rickettsia, and fungi.

Suggested Readings:
1. Medical Microbiology by Brooks G.F., Carroll K.C., Butel J.S., and Morse S.A., McGraw Hill Publication.
2. Mims' Medical Microbiology, Goering R., Dockrell H., Zuckerman M., and Wakelin D., Elsevier.
3. Prescott, Harley and Klein's Microbiology, Willey JM, Sherwood LM, & Woolverton CJ, McGraw Hill.
Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Preparation of bacterial smears from clinical samples (e.g., simulated throat swab) and Gram staining to differentiate Gram-positive and Gram-negative bacteria.
2. Isolation of pathogenic bacteria (e.g., *Staphylococcus* or *E. coli*) from a simulated clinical sample using selective media.
3. Antibiotic sensitivity testing of a bacterial isolate using the Kirby-Bauer disc diffusion method.
4. Observation of fungal pathogens (e.g., *Candida albicans*) using wet mount microscopy or prepared slides.
5. Detection of microbial contamination in a water sample using the most probable number (MPN) method for coliforms.
6. Biochemical tests (e.g., catalase, coagulase, or oxidase) to identify pathogenic bacteria like *Staphylococcus aureus*.
7. Preparation and observation of acid-fast staining for *Mycobacterium* species using prepared slides.
8. Case study analysis of a microbial disease outbreak using epidemiological data and identification techniques.

25UN-BIT-405
Introduction to IPR

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide an understanding of intellectual property rights (IPR), including patents, trademarks, and copyrights, and their application in biotechnology. To develop practical skills in patent searching, understanding international treaties, and analyzing ethical and biosafety considerations in biotechnological research.

Course outcomes:
CO1: Gain knowledge about Intellectual Property Rights to protect biological inventions.
CO2: Understand the process of filing patent, different treaties, and the rights and duties of patent owners.
CO3: Understand the processes involved in patenting, patent searching, and the protocols for ethical permissions etc.
CO4: The course enables students to make their careers as Patent Officers, Patent filing agents, or IP consultants.

Unit I

Introduction to intellectual property: Introduction. Types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge and geographical indications. Case studies related to popular IPs.

Unit II

International organizations for IPR standards: Establishment and functions of GATT, WTO and WIPO; main features of TRIPS agreement; WIPO treaties and PCT. Case studies.

Unit III

Concept of 'prior art': Invention in context of "prior art"; patent databases; basics of patents: types of patents, Indian Patent Act 1970 and recent amendments; types of patent applications. Case studies.

Unit IV

Patent protection; PCT and convention patent applications; patent application forms and guidelines, fee structure, and time frames; international patenting-requirements, procedures and costs; patent infringement- meaning, scope, litigation; patent dispute case studies and examples.

Suggested Readings:

1. Laws relating to Intellectual Property Rights by VK Ahuja, Lexis Nexis Publishers.
2. IPR, Biosafey and Bioethics by Deepa Goel and Somini Prashar, Pearson.
3. An Introduction to Ethical, Safety & Intellectual Property Rights Issues in Biotechnology. Padma Nabisan, Elsevier.
4. Biotechnology and Intellectual Property Rights by Kshitij Kumar Singh, Springer.
5. A Guide to Biotechnology Law and Business by Robert A. Bohrer,Carolina Academic Press.
6. Bioethics and Biosafety, M.K. Sateesh, Kindle Edition.
7. IPR, Biosafety and Bioethics, Shomini Parashar, Deepa Goel, Pearson India.
8. Private Power, Public Law: The Globalization of Intellectual Property Rights, Susan K. Sell, Cambridge Univ Press
9. Essentials of Intellectual Property: Law, Economics, and Strategy, Alexander I. Poltorak, Paul J. Lerner, Wiley
10. Biological Safety: Principles and Practices, Diane O. Fleming, Debra L. Hunt, ASM.
11. Patent Law and Entrepreneurship, Singh, I. and Kaur, B., Kalyani Publishers.
12. IPR, Biosafety and Bioethics, Goel and Prashar, Pearson Education, India.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

B.Sc. Biotechnology (Semester V)

25UN-BIT-501
Biostatistics

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of statistical principles and their application in analyzing biological data. To develop skills in designing experiments, interpreting statistical results, and critically evaluating statistical methods used in biological research.

Course outcomes:
CO1: Understand basic principles of probability and statistics.
CO2: Apply statistical methods for analyzing biological data.
CO3: Interpret and communicate statistical results effectively.
CO4: Critically evaluate statistical methods used in biological research.
CO5: Design experiments and studies using appropriate statistical techniques.

Unit I

Preliminary concepts and Presentation of data: Variables and constants; random samples; variables in biology; accuracy and precision. Types of graphs; modes of graphical representation of data; line graph; bar diagram; pie, circle and sector chart; histogram; frequency polygon; frequency curve; frequency distribution; relative and cumulative frequency distribution.

Unit II

Measures of central tendency and dispersion: Mean; median; mode, empirical relationship between mean, median and mode; Selection of the appropriate measure of central tendency, quartile, and percentile. Range; Interquartile range; mean deviation; coefficient of mean deviation; standard deviation; merits, demerits and uses of standard deviation; calculation of standard deviation.

Unit III

Tests of significance: Introduction to hypothesis testing, Parametric and non-parametric tests, degrees of freedom, level of significance, chi-square test; student's t-test; one-way ANOVA.

Unit IV

Correlation and Regression analyses: Correlation; co-variance; calculation of co-variance; correlation analysis; correlation coefficient calculated from ungrouped data; Spearson's rank correlation coefficient; estimation of correlation coefficient using scattered diagrams.Applications of correlation. Introduction to regression, linear regression equation, Regression coefficient; properties of regression coefficient applications of regression.

Suggested readings:

1. Biostatistical Analysis by Zar, Pearson Education India
2. Textbook of computer applications and biostatistics by SB Bhise *et al.*, Trinity Publishing house
3. Statistical Methods by Gupta, S.P, S. Chand & Sons, New Delhi.
4. Biostatistics by P.N. Arora and P.K. Malhan, Himalayan publishing house.
5. Introduction to Biostatistics by Robert R. Sakal and F. James Rohlf, Dover Publications, Inc. New York.
6. Introductory Biostatistics by Chap T. Le: A John Wiley & Sons Publication
7. Introduction to Biostatistics, Sokal S., & Rohit S., Toppan Publication.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Collection and organization of biological data (e.g., plant growth measurements).
2. Calculation of mean, median, and standard deviation using a dataset.
3. Plotting a bar graph to represent biological data (e.g., enzyme activity).
4. Performing a t-test to compare two biological datasets (e.g., growth rates).
5. Analysis of correlation between two variables (e.g., temperature and microbial growth).
6. Chi-square test to analyze genetic cross data (e.g., Mendelian ratios).
7. Use of spreadsheet software (e.g., Excel) for basic statistical analysis.
8. Interpretation of a biological dataset using graphical representation.

25UN-BIT-502
Introductory Biotechniques

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course aims to introduce students to basic biotechniques used in molecular biology and biotechnology, provide hands-on training in laboratory methods like PCR and electrophoresis, familiarize students with lab safety and equipment handling, and highlight the applications of these techniques in research and industry.

Course Outcomes:
CO1: Describe the principles of basic biotechniques used in molecular biology.
CO2: Students will perform techniques like DNA extraction, PCR, and gel electrophoresis.
CO3: Students will demonstrate proper lab safety and equipment handling practices.
CO4: Students will explain the applications of biotechniques in biotechnology research.

Unit I

Introduction to Biotechniques: Overview of biotechniques, including their role in biotechnology research; types of techniques, such as molecular, biochemical, and microbiological methods; importance of lab safety, including sterilization and biosafety protocols; introduction to common laboratory equipments such as, centrifuge, microscope (light, electron, and fluorescense), UV spectrophotometer, laminar hood, and PCR.

Unit II

Molecular Biology Techniques: DNA extraction and purification from plant or microbial samples; polymerase chain reaction (PCR) for amplifying DNA; agarose gel electrophoresis for DNA analysis; restriction enzymes in DNA manipulation; basic cloning techniques, including transformation in bacteria.

Unit III

Biochemical and Microbiological Techniques: Protein extraction and quantification using simple assays like Bradford method; enzyme assays to study activity, such as amylase or catalase; microbial culturing techniques, including streak plating and spread plating; identification of microbes using Gram staining.

Unit IV

Applications and Instrumentation: Applications of biotechniques in genetic engineering, diagnostics, and food biotechnology; analysis in biotechnology experiments, including gel imaging; future trends in biotechniques, such as high-throughput sequencing and automation.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual. Sambrook, J., & Russell, D. W. Cold Spring Harbor Laboratory Press.
2. Principles and Techniques of Biochemistry and Molecular Biology. Wilson, K., & Walker, J. Cambridge University Press.
3. Culture of Animal Cells. Freshney, R. I. Wiley-Blackwell.
4. Introductory Practical Biochemistry, Sawhney, S.K. and Singh R., Alpha Science International.
5. Biophysical Chemistry: Principles & Techniques, Upadhayaye, A., Upadhayaye, K., and Nath N., Himalaya Publication.
6. Articles from Journal of Visualized Experiments (JoVE) on biotechniques.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:

1. Extraction of DNA from plant material (e.g., spinach) and visualization.
2. Perform PCR to amplify a specific DNA fragment.
3. Analysis of DNA using agarose gel electrophoresis.
4. Gram staining of bacterial samples to identify cell types.
5. Protein quantification using a colorimetric assay.
6. Demonstration of restriction enzyme digestion of DNA.
7. Culturing bacteria on nutrient agar using streak plate method.
8. Use of a spectrophotometer to measure DNA concentration.

25UN-BIT-503
Fundamentals of Enzymology

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of enzyme characteristics, kinetics, mechanisms, and purification techniques. To develop practical skills in enzyme assays, purification, and kinetic parameter determination.

Course Outcomes:
CO1: Learn various characteristics of enzymes, classify them, and elaborate on the role of cofactors in enzyme catalysis.
CO2: Correlate the structure of enzymes to their functions, the mechanism of enzyme catalysis.
CO3: Exhibit the knowledge of enzyme kinetics and different types of inhibitions.
CO4: Discuss techniques of enzyme isolation, purification, and immobilization.

Unit I

Introduction and history of Enzymology: General characteristics, nomenclature and classification of enzymes. Significance of the numbering system. Introduction to terms: holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, active site, metallo-enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes, multifunctional enzyme, and multi-enzyme complexes, Abzymes, and Ribozymes. Enzyme purification. Enzyme units, turnover number, and specific activity.

Unit II

Role of cofactors in enzyme catalysis: Enzyme cofactors and their role, NAD/NADP, FMN/FAD, CoA, biocytin, Vit B12, tetrahydrofolate, and metal ions. Action mechanism of chymotrypsin, carboxypeptidase, and ribonuclease.

Unit III

Introduction to Enzyme Kinetics: Factors affecting enzyme activity (enzyme concentration, substrate concentration, pH, and temperature). Derivation of the Michaelis-Menten equation for a uni-substrate reaction. Km and its significance. Lineweaver-Burk plot. Importance of Kcat/Km.

Unit IV

Enzyme inhibition, regulation and applications: Reversible (competitive, non-competitive, and uncompetitive inhibitions) and irreversible inhibition. Enzyme regulation: Feedback inhibition, Allosteric enzymes. Clinical aspects of Enzymology. Applications of enzymes in food industry, pharmaceuticals, biofuels and detergents. Enzyme biotechnology of glucose isomerase for high-fructose corn syrup production.

Suggested Readings:

1. Structure and Mechanism in Protein Science, by Alan Fersht, World Scientific.
2. Fundamentals of Enzymology by Nicholas C. Price and Lewis Stevens, Oxford University Press.
3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, Philip Bonner, East West Publishing.
4. The Chemical Kinetics of Enzyme Action, K.J. Laidler and P.S. Bunting, Oxford University Press, London.
5. An Introduction to Practical Biochemistry by David Plummer, Tata McGraw Hill.
6. Introductory Practical Biochemistry by S.K. Sawhney & R. Singh, Narosa Publishers.
7. Modern Experimental Biochemistry by R. Boyer, Addison-Wesley Longman.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-504
Cell and Tissue Culture

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Outcomes:
CO1: Describe the basic principles and components of cell and tissue culture.
CO2: Perform simple cell and tissue culture techniques, such as media preparation and explant culturing.
CO3: Explain the applications of cell and tissue culture in biotechnology and agriculture.
CO4: Students will identify basic laboratory safety and sterilization practices used in cell and tissue culture.

Unit I

Introduction to Cell and Tissue Culture: Overview of cell & tissue culture, including its definition and importance in biotechnology; types of cultures, such as plant callus culture, suspension culture, and animal cell lines; basic requirements for culturing, including sterile conditions, culture media, & growth factors; differences between plant & animal cell cultures.

Unit II

Laboratory Setup and Sterilization: Essential laboratory equipment for cell and tissue culture, such as laminar flow hoods, autoclaves, and incubators; basic sterilization techniques, including autoclaving, surface sterilization, and filtration. importance of maintaining aseptic conditions in the laboratory.

Unit III

Techniques in Cell and Tissue Culture: Preparation of culture media, like Murashige and Skoog (MS) medium for plants and simple media for animal cells. Basic techniques for plant tissue culture, including explant preparation and callus induction; simple animal cell culture methods, such as trypsinization and maintaining cultures. Observation of cell growth and differentiation in cultures.

Unit IV

Applications of Cell and Tissue Culture: Applications in plant biotechnology, such as micropropagation for producing disease-free plants and clonal propagation; applications in animal biotechnology, including production of vaccines and cell-based therapies; examples of commercial products, like tissue-cultured banana plants and monoclonal antibodies; introduction to ethical considerations, such as animal cell use and biosafety.

Suggested Readings:

1. Plant Tissue Culture: Theory and Practice. Bhojwani, S. S., & Razdan, M. K. Elsevier.
2. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Freshney, R. I. (2021). Wiley-Blackwell.
3. Plant Tissue Culture: Techniques and Experiments. Smith, R. H. Academic Press.
4. Articles from In Vitro Cellular & Developmental Biology & Plant Cell, Tissue & Organ Culture on introductory concepts.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-505 Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Foundations of Environment and Ecology Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of ecological concepts, biological interactions, biogeochemical cycles, biodiversity, and environmental pollution. To develop practical skills in analyzing environmental samples for physicochemical parameters.

Course Outcomes:
CO1: Describe basic concepts of ecology and ecosystem.
CO2: Describe the various biological interactions and the relationship between abiotic and biotic factors.
CO3: Understand biogeochemical cycles and the concept of biodiversity.
CO4: Understand the causes of different types of pollution and their management strategies.
CO5: Measure various physicochemical parameters of water samples.

Unit I

Basic concepts of ecology: Definition, significance. Concepts of habitat and ecological niche. Ecosystem: Concept, components, properties, and functions; Ecological energetics and energy flow - food chain, food web, trophic structure; ecological pyramids, concept of productivity.

Unit II

Factors affecting environment: Abiotic factors (light - intensity, quality, and duration), temperature, humidity, wind, rainfall, topography; edaphic factors; Biotic factors. Introduction to major ecosystems of the world.

Unit III

Biogeochemical cycles: Concept, reservoir pool, gaseous cycles, and sedimentary cycles. Population: Growth and regulation. Concept of biodiversity and conservation of natural resources.

Unit IV

Population interactions: Competition, predation, parasitism, commensalism, and mutualism. Environmental pollution: Soil, water, air, radiation, landscape, noise. Detection of environmental pollutants. Hazardous wastes, environmental cleanup, bioremediation, waste disposal.

Suggested Readings:
1. Fundamentals of Ecology, Odum E.P.
2. Wastewater Engineering – Treatment, Disposal and Reuse, Metcalf & Eddy, Tata McGraw Hill.
3. Environmental Pollution Control Engineering, Rao C.S., New Age International Publication.
Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-506
Foundations of Nanobiotechnology

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To introduce students to the fundamentals of nanotechnology and its applications in biology, including the synthesis, characterization, and biological interactions of nanomaterials. To discuss ethical, safety, and societal implications and develop practical skills in nanoparticle synthesis and analysis.

Course Outcomes:
CO1: Explain the principles and applications of nanotechnology in biological systems.
CO2: Describe the synthesis and characterization techniques for nanomaterials in bio-nanotechnology.
CO3: Analyze interactions between nanoparticles and biological systems.
CO4: Evaluate applications of bio-nanotechnology in drug delivery, biosensing, and tissue engineering.
CO5: Discuss ethical, safety, and societal implications of bio-nanotechnology, including environmental impacts.

Unit I

Introduction to Bio-Nanotechnology: Cellular nanostructures, self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles), Nanoparticles for drug delivery (including solid lipid nanoparticles, synthetic and biopolymeric nanoparticles).

Unit II

Semiconductor and Metal Nanoparticles: Synthesis and Applications, Nanotechnology in Tissue Engineering, Microemulsions and Drug Delivery in Nanotechnology. Overview of current industry applications; nanoscale science and engineering principles.

Unit III

Nanostructures: Carbon nanotubes, polymeric nanofibers, Implications in neuroscience, tissue engineering, and cancer therapy. Environmental and safety aspects of bio-nanotechnology.

Unit IV

Bionanotechnology: Nanotechnology (Definitions, history, and current practice), Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, smart capsules, Layer by layer (LbL) self-assembly, Colloids and Colloid Assemblies for Bio-nanotechnology, Nanoengineered biosensors, Fiber Optic Nano-sensors in medical care.

Suggested Readings:

1. Multilayer Thin Films, Decher G., Schlenoff J.B., Wiley-VCH Verlag GmbH & Co. KGaA.
2. Bio-nanotechnology: Lessons from Nature, Goodsell D.S., Wiley-Liss.
3. Nanotechnology - A Gentle Introduction to the Next Big Idea, Ratner and Ratner, Prentice Hall PTR.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-507
Pharmaceutical Biotechnology

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of biotechnological techniques used in pharmaceutical research, development, and production. To develop skills in applying biotechnological tools for designing novel pharmaceutical products and understanding regulatory and ethical considerations.

Course Outcomes:
CO1: Learn the fundamental biotechnological techniques used in pharmaceutical research and development.
CO2: Apply biotechnological tools to design and produce novel pharmaceutical products.
CO3: Understand the regulatory requirements and ethical considerations in pharmaceutical biotechnology.
CO4: Proficient in critically analyzing current trends and challenges in the field of pharmaceutical biotechnology.

Unit I

Introduction to Pharmaceutical Biotechnology: Overview of the principles and applications of biotechnology in the pharmaceutical industry. Fundamentals of biopharmaceutical production processes. Biotechnology in drug discovery, development, and production. Regulatory frameworks governing the biopharmaceutical sector.

Unit II

Biopharmaceutical Product Development: Development of biopharmaceutical products, including monoclonal antibodies, therapeutic proteins, and gene therapies. Design and engineering of biologics, as well as the optimization of production processes for large-scale manufacturing. Quality control, validation, and regulatory requirements for biopharmaceutical development.

Unit III

Bioprocessing and Manufacturing: Bioprocessing techniques and manufacturing strategies used in the production of biopharmaceuticals. Cell culture methods, downstream processing, purification techniques, and formulation considerations.

Unit IV

Advanced Topics in Pharmaceutical Biotechnology: Emerging trends in pharmaceutical biotechnology. Recent developments in areas such as personalized medicine, gene editing technologies, and the development of biosimilars. Ethical considerations, regulatory challenges, and future directions in Pharmaceutical Biotechnology.

Suggested Readings:

1. Molecular Biotechnology, Glick, B.R., & Pasternak, J.J., ASM Press.
2. Pharmaceutical Biotechnology: Principles and Applications, Dey, G., & Chatterjee, J. CRC Press.
3. Advances in Pharmaceutical Biotechnology, Singh, S. Academic Press.
4. Pharmaceutical Biotechnology: Concepts and Applications, Ratledge, C., & Kristiansen, B. Wiley.
5. Recent Advances in Pharmaceutical Biotechnology, Gupta, P.K., & Sharma, G. Springer.
6. Advances in Animal Biotechnology, Singh, B., Gautam, S.K., Mukesh, M., Springer.
7. Handbook of Pharmaceutical Biotechnology, Gad, S.C. Wiley.
8. Pharmaceutical Biotechnology: Fundamentals and Applications, Gaur, R., & Sharma, A.K. Springer.
9. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, Jain, K.K., Wiley.
10. Biotechnology for Pharmaceutical Industries: Perspectives and Challenges, Singh, R.S., & Upadhyay, S.K. Elsevier.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-508
Molecular Medicine

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of molecular medicine, gene therapy, and their applications in treating human diseases. To explore the molecular basis of diseases, diagnostic techniques, and the role of stem cells and small molecules. To develop practical skills in molecular techniques such as PCR, transfection, and bioinformatics analysis.

Course Outcomes:
CO1: Explain the scope, history, and research areas of molecular medicine and gene therapy.
CO2: Analyze the molecular mechanisms underlying disease development (e.g., cancer, neurodegenerative diseases).
CO3: Describe the applications of stem cells and small molecules in disease treatment and drug discovery.
CO4: Evaluate gene therapy approaches, including viral and non-viral vectors, for treating genetic disorders.
CO5: Perform molecular techniques such as PCR, transfection, and bioinformatics analysis for molecular medicine research.

Unit I

Introduction to Molecular Medicine: Definition, scope, and historical perspective. Concept of Molecular Medicine: Need, Significance, and Limits of Molecular Medicine, Development of Molecular Medicine, Applications of Molecular Medicine for curing human diseases.

Unit II

Molecular Basis of Diseases: Genetic vs. acquired diseases, Molecular mechanisms underlying common diseases (e.g., cancer and neurodegenerative diseases). Diagnostic Techniques in Molecular Medicine: Polymerase chain reaction (PCR), DNA sequencing, and microarray analysis, Molecular imaging techniques (e.g., PET, MRI).

Unit III

Stem Cells and Small Molecules in Molecular Medicine: Stem cells and their regenerative potential, Stem cell therapy for neurodegenerative diseases, Cardiac regeneration using stem cells. Small molecules: Importance of small molecules in molecular medicine and drug discovery, role of small molecules in disease treatment.

Unit IV

Gene Therapy: Principles and Applications: Concept and history of gene therapy. Types of gene therapy: somatic vs. germline, ex vivo vs. in vivo. Vectors for Gene Delivery: Viral vectors (retrovirus, adenovirus, adeno-associated virus). Non-viral vectors (liposomes, nanoparticles). Applications in correcting genetic disorders. Challenges and ethical considerations in gene therapy.

Suggested Readings:

1. Principles of Molecular Medicine, Jameson, J.L., & Fauci, A.S., Humana Press.
2. Gene Therapy, Giacca, M., Springer.
3. Molecular Medicine: An Introductory Text, Trent, R.J., Academic Press.
4. Gene Therapy: Principles and Applications, Wolfe, T.M., & Lipinski, D.J., Wiley.
5. Advances in Animal Biotechnology, Singh, B., Gautam, S.K., Mukesh, M., Springer International Publishing.
6. Molecular Medicine: Genomics to Personalized Healthcare, Arora, R., & Gupta, P., Elsevier.
7. Essentials of Stem Cell Biology and Gene Therapy, Lanza, R., Atala, A., & Thomson, J.A., Academic Press.
8. Gene Therapy: A Handbook for Physicians, Press, O.W., CRC Press.
9. Molecular Medicine: An Introduction, Cook, R.E., Wiley-Liss.
10. Gene Therapy: Therapeutic Mechanisms and Strategies, O'Carroll, C.D., Academic Press.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-509
Viruses and Diseases

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course helps to understand the role of viruses in causing human and animal diseases. It explores the mechanisms of viral infection, pathogenesis, and transmission and develops skills in viral diseases diagnosis and disease prevention, including vaccines and antivirals.

Course Outcomes:
CO1: Describe the mechanisms of viral infection and disease causation.
CO2: Apply diagnostic techniques to identify viral pathogens in clinical samples.
CO3: Analyze the epidemiology and impact of viral diseases on public health.
CO4: Students will design strategies for the prevention and treatment of viral diseases.

Unit I

Introduction to Viruses and Disease: Overview of viruses as disease-causing agents, including their classification as DNA, RNA, enveloped, and non-enveloped viruses; structure of viruses, encompassing capsid, envelope, and genomic organization; viral infection processes, including attachment, entry, and replication; introduction to viral diseases, focusing on their impact on human and animal health.

Unit II

Pathogenesis and Epidemiology of Viral Diseases: Mechanisms of viral pathogenesis, including immune evasion, tissue tropism, and cellular damage; major viral diseases, such as influenza, HIV/AIDS, and viral hepatitis; Global pandemics; case studies of SARS-CoV-2 and Zika viruses.

Unit III

Diagnostic Techniques for Viral Diseases: Diagnostic methods, including virus isolation in cell lines and embryonated eggs. RT-PCR, and next-generation sequencing for viral detection; ELISA, neutralization tests, and rapid diagnostic tests; biosafety considerations in handling clinical samples.

Unit IV

Prevention and Treatment of Viral Diseases: Vaccine strategies, including mRNA and viral vector vaccines; antiviral therapies and mechanisms of action of nucleoside analogs and protease inhibitors. Drug resistance; quarantine, challenges in disease control, including vaccine hesitancy, and viral mutations.

Suggested Readings:
1. Fields Virology. Knipe, D. M., & Howley, P. M. Wolters Kluwer.
2. Principles of Virology Flint, S. J., et al. ASM Press.
3. Clinical Virology. Richman, D. D., et al. ASM Press.
4. Articles from Emerging Infectious Diseases and The Lancet Infectious Diseases on viral diseases.
Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Perform RT-PCR to detect viral RNA (e.g., SARS-CoV-2) in a simulated clinical sample.
2. Conduct an ELISA assay to detect antibodies against a viral pathogen.
3. Analyze viral disease epidemiology using public health datasets and statistical tools.
4. Simulate vaccine development strategies using bioinformatics tools for antigen prediction.

B.Sc. Biotechnology (Semester VI)

25UN-BIT-601
Genomics and Proteomics

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objective: This course provides a comprehensive understanding of genomics and proteomics, including their fundamental principles, techniques, and applications. The course will also explore the applications of genomics and proteomics in medicine, diagnostics, and personalized medicine, with a focus on the human genome project and future directions in these fields.

Course Outcomes:
CO1: Describe the principles of genomics and proteomics.
CO2: Explain techniques for analyzing genes and proteins.
CO3: Perform basic genomic and proteomic experiments.
CO4: Students will identify applications of genomics and proteomics in biotechnology.

Unit I

Introduction to Genomics: Overview and scope of genomics, genome organization, genome sequencing strategies and programs, methods for sequence alignment and gene annotation; Analyzing differential expression of genes - ESTs, SAGE, microarrays. BLAST and sequence alignment, introduction to genome databases, like NCBI and Ensembl.

Unit II

Genomic Techniques: Comparative genomics of model plants and related crop species; Recombination-based cloning techniques; genome imprinting. Genomic tools to study gene tagging, gene and promoter trapping, methylome and histone modifications.

Unit III

Introduction to Proteomics: Overview and scope of proteomics. Analysis of proteins by CD and NMR, protein identification and analysis on ExPASy server, other protein related databases, Mass spectrometry based method for protein identification like PMF and LCMS.

Unit IV

Applications of Genomics and Proteomics: Applications in medicine, genetic diagnostics and personalized medicine; gene editing and protein engineering. case study of Human Genome Project. Single-cell genomics and proteomics. Protein chips and arrays, future directions in proteomics.

Suggested Readings

1. Genomes. Brown, T. A. Garland Science.
2. Principles of Proteomics. Twyman, R. M. Garland Science.
3. Introduction to Genomics. Lesk, A. M. Oxford University Press.
4. Biochemistry and Molecular Biology of Plants, Buchanan B, Gruissem G, and Jones R. American Society of Plant Physiologists, USA.
5. Spectroscopy for the Biological Sciences. Hammes GD. Wiley Interscience, USA.
6. Introduction to Proteomics: Tools for New Biology. Lieber DC. Humana Press, NJ.
7. Proteomics: From Protein Sequence to Function, Pennington SR, Dunn MJ. BIOS Scientific Publishers
8. Molecular Cloning – A Laboratory Manual, Sambrook J and Russell DW. Cold Spring Harbor Laboratory, USA.
9. Genes and Genomes: A Changing Perspective. Singer M and Berg P. University Science Books, CA, USA.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical

1. DNA extraction from microbial cells and visualization.
2. Perform PCR to amplify a specific gene fragment.
3. Analysis of DNA using agarose gel electrophoresis.
4. Protein extraction and separation using SDS-PAGE.
5. Simulation of genome analysis using BLAST.
6. Study of protein expression using a simple assay.
7. Analysis of a genomic database (e.g., NCBI) for gene information. Case study on a genomics or proteomics application.

25UN-BIT-602
Genetics and Development Biology

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Outcomes:
CO1: Students will describe the basic principles of genetics and their role in developmental processes.
CO2: Students will explain how genes control embryonic development and differentiation in simple terms.
CO3: Students will perform basic experiments to analyze genetic inheritance and developmental stages.
CO4: Students will identify applications of developmental genetics in biotechnology and medicine.

Unit I

Introduction: Basic concepts of genetics, such as genes, alleles, and Mendelian inheritance (monohybrid and dihybrid crosses); introduction to developmental biology, including stages like fertilization, cleavage, and gastrulation in model organisms (Drosophila, Arabidopsis); outlining the flow of genetic information from DNA to protein in developmental contexts.

Unit II

Genetic Inheritance and Early Development: Principles of genetic inheritance, including dominant and recessive traits, Punnett squares, and simple pedigree analysis. Introduction to fertilization, cell division and differentiation in plants and animals; role of maternal effect genes in early development of *Drosophila*. Genetic variation influencing developmental traits, like flower color in plants.

Unit III

Gene Regulation in Development: Mechanisms of gene regulation in development, transcription factors regulating gene expression; pattern-forming genes in shaping body plans of *Drosophila* and plants. Gastrulation and organogenesis in animals and meristem development in plants; Wnt gene in coordinating development; epigenetic effect of DNA methylation on developmental gene expression.

Unit IV

Applications of Developmental Genetics: Applications of genetics in studying developmental processes, analyzing mutants for trait improvement; genetic modification for enhanced crop traits. Genetic basis in pluripotency in stem cells. Case studies of *Arabidopsis* floral mutants and genetic engineering for disease resistance; gene editing for developmental studies.

Suggested Readings:
1. Developmental Biology. Gilbert, S. F., & Barresi, M. J. F. Sinauer Associates.
2. Principles of Development. Wolpert, L., & Tickle, C. Oxford University Press.
3. Principles of Genetics. Snustad, D. P., & Simmons, M. J. Wiley.
4. Genomes. Brown, T. A. Garland Science.
5. Introduction to Genetic Analysis. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. W.H. Freeman.
6. Articles from Nature Education and Journal of Developmental Biology on developmental genetics basics.
Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Observation of developmental stages in Drosophila larvae using a microscope.
2. Analysis of Mendelian inheritance using a monohybrid cross in plants (e.g., pea plants).
3. Extraction of DNA from plant tissue (e.g., Arabidopsis) for genetic analysis.
4. Perform PCR to amplify a developmental gene (e.g., a homeobox gene).
5. Analysis of PCR products using agarose gel electrophoresis with a safe dye.
6. Study of Arabidopsis seedling development under different conditions (e.g., light or nutrient levels).
7. Pedigree analysis to study inheritance patterns in a simulated family.
8. Case study on the application of developmental genetics in crop improvement or medical research.

25UN-BIT-603
Biotechnology and Food Security

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objective: This course aims to explore the role of biotechnology in addressing global food security challenges. It will cover the definition and importance of food security, the application of biotechnology in agriculture (including genetic engineering and biofortification), and the ethical and regulatory considerations surrounding these technologies. The course will also examine the impact of biotechnology on food production systems and explore future directions for climate-resilient agriculture.

Course Outcomes:
CO1: Describe biotechnological strategies to address food security challenges.
CO2: Design experiments to develop genetically modified crops with enhanced traits.
CO3: Evaluate the impact of biotech innovations on sustainable agriculture.
CO4: Students will critically assess the regulatory and ethical issues in biotech food production.

Unit I

Introduction to Biotechnology and Food Security: Definition and importance of food security utilization, and stability. Role of biotechnology in agriculture, GM crops, biofortification, and pest control. Comparing the green revolution with the Biotech revolution. Global challenges such as population growth, climate change, and increasing food demand.

Unit II

Genetic Engineering for Crop Improvement: Genetic engineering techniques, including transgenic crops and CRISPR-based gene editing; development of traits for food security, such as drought tolerance, pest resistance, and nutrient enhancement; biofortification, focusing on examples like Golden Rice and iron-fortified crops; case studies on Bt crops and their impact on yield and pesticide use.

Unit III

Biotechnological Innovations in Food Production: Microbial biotechnology, including fermentation for food preservation and value addition; plant tissue culture techniques, such as micropropagation and production of disease-free planting material; precision agriculture using biotech sensors and data analytics; alternative protein sources.

Unit IV

Regulatory and Ethical Considerations: Regulatory frameworks for GMOs, ethical issues and equity in access to biotech foods. Biosafety protocols, risk assessment, and containment strategies. Future biotechnology for climate-resilient agriculture, global warming and food security. Case study of countries with adopted food security models.

Suggested Readings:

1. Transgenics and the Poor: Biotechnology in Development Studies. Herring, R. J. Routledge.
2. Food Security: Policy and Challenges. Pinstrup-Andersen, P. Cornell University Press.
3. Genetically Modified Crops and Agricultural Development. Qaim, M. Palgrave Macmillan.
4. Food Biotechnology. Bielecki, S., Tramper, J., & Polak, J. Elsevier.
5. Food Biotechnology. Shetty, K., Paliyath, G., Pometto, A., & Levin, R. E. CRC Press.
6. Modern Biotechnology: Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals. Mosier, N. S., & Ladisch, M. R. Wiley.
7. Articles from Trends in Biotechnology and Food Security journal on biotech applications.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-604
Bioentrepreneurship

Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of entrepreneurial principles in biotechnology, including organizational management, government schemes, and quality control. To develop practical skills in assessing entrepreneurial potential and creating business plans for biotech enterprises.

Course Outcomes:
CO1: Explain the organizational structure, management, and role of innovation in biotech enterprises.
CO2: Describe government schemes and policies for biotechnology commercialization.
CO3: Analyze operational research tools (e.g., PERT, CPM) and management strategies for biotech enterprises.
CO4: Evaluate quality control parameters and government regulations for biotech products.
CO5: Assess entrepreneurial potential through tests and develop business plans for biotech industries.

Unit I

Introduction: Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology. Organizational structure & Management. Capital Management. Product innovation and management. Government schemes for commercialization of technology (e.g., Biotech Consortium).

Unit II

Basics of production management: Methods of manufacturing - Project/Jobbing, Batch Production, Flow/Continuous production, process production - Characteristics of each method. Plant location - Importance, Factors affecting location, factory building, Plant layout - Installation of Facilities.

Unit III

Operational Research: Linear Programming, PERT, and CPM; Production Planning and Control - Scheduling - Gantt Charts - Documentation - Production Work Order. Kaizen (Continuous improvement in product & management). Biotech enterprises: Small, Medium, and Large.

Unit IV

Quality control in Biotech industries: Government regulations for biotech products. Public policy, regulatory, and ethical challenges facing biotechnology entrepreneurship. Business development for medical products.

Suggested Readings:

1. Entrepreneurship: New Venture Creation, Holt D.H.
2. Patterns of Entrepreneurship, Kaplan J.M.
3. Entrepreneurship and Small Business Management, Gupta C.B., Khanka S.S., Sultan Chand & Sons.
4. Innovation and Entrepreneurship in Biotechnology: Concepts, Theories & Cases, Hyne D., and Kapeleris J.
5. Entrepreneurship in Biotechnology: Managing for Growth from Start-up, Martin Gross Mann.
6. Best Practices in Biotechnology Education, Friedman Y., Logos Press.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-605 Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Biotechnology of Vaccines Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course aims to introduce students to the principles of vaccine development using biotechnology, explore the types and production of vaccines, provide hands-on experience in basic techniques related to vaccine development, and highlight the role of vaccines in public health and disease prevention.

Course Outcomes:
CO1: Describe the principles and types of vaccines.
CO2: Explain biotechnological methods for vaccine production.
CO3: Students will evaluate vaccine antigen analysis.
CO4: Propose the role of vaccines in public health and disease control.

Unit I

Introduction to Vaccines: Overview of vaccines, including their history and importance in disease prevention; types of vaccines, such as live attenuated, inactivated, and subunit vaccines; role of biotechnology in vaccine development; examples of vaccines, like polio and hepatitis B vaccines.

Unit II

Vaccine Design and Antigens: Identification of vaccine antigens using basic molecular techniques; role of recombinant DNA technology in producing vaccine antigens; use of adjuvants to enhance immune response; introduction to vaccine testing for safety and efficacy.

Unit III

Vaccine Production: Bioprocessing for vaccine production, including microbial and cell culture systems; purification of vaccine antigens using simple methods; quality control in vaccine manufacturing; case studies on biotech vaccines, like HPV vaccine.

Unit IV

Public Health and Challenges: Role of vaccines in public health, including herd immunity; challenges in vaccine distribution, such as cold chain requirements; ethical issues, like vaccine access and hesitancy; future trends, including mRNA vaccines and universal vaccines. Case study of Polio and Covid vaccine.

Suggested Readings

1. Plotkin's Vaccines. Plotkin, S. A., Orenstein, W. A., & Offit, P. A. Elsevier.
2. New Generation Vaccines. Levine, M. M. CRC Press.
3. Designing Tomorrow's Vaccines. Nabel, G. J. New England Journal of Medicine.
4. Articles from Vaccine and Nature Reviews Immunology.
5. Immunology by Kuby J. W.H. Freeman & Co., New York.
6. Cellular and Molecular Immunology by Abul K Abbas et al., Elsevier, Inc.
7. Immunology: A Short Course by Coico, Richard and Sunshine, Geoffrey. Willey-Blackwell Press.
8. Essential Immunology by Roitt, I.M. Oxford Black Well Science, London.
9. Immunology by Raj Khanna, Oxford Press.
10. Immunology and Immunotechnology by Chakravarty AK, Oxford press.
11. The Elements of Immunology by Fahim Halim Khan, Pearson Education

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-606 Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Biotechnology for Sustainable Development Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Course Outcomes:
CO1: Explain how biotechnology contributes to sustainable development.
CO2: Design bioremediation experiments for environmental cleanup.
CO3: Students will evaluate the sustainability of biotech processes using life cycle assessment.
CO4: Propose solutions to overcome challenges in scaling biotech for sustainability.

Unit I

Introduction to Biotechnology and Sustainability: Role of biotechnology in achieving sustainable development goals (SDGs); principles of green biotechnology, focusing on eco-friendly processes and products; bioremediation, including microbial degradation of pollutants; case studies on biotech solutions for clean water and soil restoration.

Unit II

Biotechnology in Renewable Resources: Production of bioethanol, biodiesel, and biogas. Bioplastics, focusing on synthesis and applications of polyhydroxyalkanoates (PHA) and polylactic acid (PLA); enzyme technology for sustainable industrial processes; waste valorization, converting agricultural & industrial waste into value-added products.

Unit III

Environmental Biotechnology Applications: Microbial bioremediation for oil spills, heavy metals, and plastics; phytoremediation using plants for environmental cleanup; synthetic biology for engineering microbes for sustainable chemical production; biotechnological approaches for carbon capture and sequestration.

Unit IV

Challenges and Future Directions: Environmental impact assessment of biotech processes; regulatory frameworks, including biosafety and environmental regulations; social and economic challenges, such as adoption and scalability in developing nations; future trends in biotechnology for circular economy and net-zero goals. Case studies.

Suggested Readings:
1. Biotechnology for Sustainable Environment. Thangadurai, D., & Sangeetha, J. Springer.
2. Biotechnology: Applying the Genetic Revolution. Clark, D. P., & Pazdernik, N. J. Academic Press.
3. Environmental Biotechnology: Sustainable Remediation. Singh, R. L., & Mondal, P. K. CRC Press.
4. Articles from Journal of Cleaner Production and Biotechnology for Biofuels on sustainability.
Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

25UN-BIT-607 Maximum Marks: 100 Theory Examination: 70 Time: 3 hrs
Diagnostic Laboratory Techniques Internal Assessment: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of fourteen (fourteen marks) short answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To introduce students to diagnostic laboratory techniques, emphasizing specimen collection, handling, and analysis using hematology, clinical chemistry, microbiology, and microscopy. To develop practical skills in laboratory safety, quality control, and the use of diagnostic equipment for accurate and reliable results.

Course Outcomes:
CO1: Explain the principles of diagnostic laboratory techniques, including sensitivity, specificity, and quality control.
CO2: Demonstrate skills in collecting, handling, transporting, and storing clinical specimens with biosafety precautions.
CO3: Apply microscopy, hematology, and clinical biochemical tests for diagnostic analysis.
CO4: Perform infectious disease testing, including culture techniques and antimicrobial susceptibility assays.
CO5: Implement laboratory safety protocols, quality control measures, and use of diagnostic equipment for reliable results.

Unit I

Overview of diagnostic laboratory techniques: Diagnostic laboratory techniques and their significance in healthcare. Basic principles of diagnostics: sensitivity, specificity, accuracy, precision. Quality control and assurance in diagnostic laboratories. Laboratory skills, safety guidelines, and procedures. Laboratory equipment and instrumentation. Laboratory documentation and record-keeping.

Unit II

Collection and handling of clinical specimens: Specimen collection, transportation, storage, and quality assessment. Biosafety precautions during specimen handling. Future trends and advancements in diagnostics.

Unit III

Hematology and Biochemistry Tests: Blood cell morphology and identification. Hematological tests (e.g., complete blood count, erythrocyte sedimentation rate). Coagulation tests and interpretation. Automated hematology analyzers and coagulation instruments. Clinical Chemistry and Biochemical Tests: Basics of clinical chemistry and biochemical analysis, common biochemical tests (e.g., liver function tests, kidney function tests). Enzyme assays and immunoassays.

Unit IV

Microscopy and Staining Techniques: Light microscopy and its applications in diagnostics. Microscopic examination and interpretation of stained specimens. Digital imaging and image analysis in microscopy. Testing and identification of infectious diseases using biochemical, molecular, and rapid diagnostic tests. Microbiological culture techniques. Antimicrobial susceptibility testing for infectious diseases.

Suggested Readings:

1. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkar.
2. Practical Clinical Biochemistry: Methods and Interpretations by S. Ashfaq Ahmed.
3. Clinical Pathology and Clinical Biochemistry by Abhijit B. Chaudhari.
4. Clinical Biochemistry: Theory and Practical by Dr. B. Ramesh, Dr. R. Nandini, and Dr. R. Anuradha.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

B.Sc. Biotechnology (Semester VI)

25UN-BIT-608
Microbial Genetics

Maximum Marks: 100 Theory Examination: 50 Time: 3 hrs
Internal Assessment: 20 Practical Examination: 30

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of ten (ten marks) short answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: To provide students with an understanding of prokaryotic genome structure, DNA replication, mutations, genetic exchange mechanisms, and bacteriophage life cycles. To develop practical skills in microbial culture preparation, genetic material isolation, and analysis.

Course Outcomes:
CO1: Describe the structure and replication mechanisms of prokaryotic genomes.
CO2: Explain mutation types and DNA repair mechanisms in prokaryotes.
CO3: Analyze genetic exchange mechanisms, including transformation, transduction, and conjugation.
CO4: Describe the lytic and lysogenic life cycles of bacteriophages (e.g., T4, lambda).
CO5: Perform microbial culture preparation, genetic material isolation from *E. coli*, and related analyses.

Unit I

Prokaryotic Genomes: Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication and partitioning of the bacterial genome). Mechanism and experimental evidence for semi-conservative replication, proof reading, inhibitors in prokaryotic replication.

Unit II

Mutations: Spontaneous and induced (physical and chemical mutagens), DNA repair mechanisms, Direct repair- photolyase and Ada, Mismatch repair- mutSLH, Recombinational repair- recA, recFOR, recBCD, SOS and translation synthesis- umuCD, Mutator genes. Molecular mechanisms of mutations: Point mutations, base substitution-transition and transversion (frameshift mutations, deletion, addition).

Unit III

Genetic Transformation: Griffith's Experiment, Genetic change: transformation, transduction, conjugation, plasmids. Mechanism of genetic exchange: Plasmid and bacterial sex, Types of plasmids (F Plasmid: a Conjugate plasmid, Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes. Transposable elements (Insertion sequence and transposons, Integrons and Antibiotic-Resistance cassettes, Multiple Antibiotic Resistant bacteria, Mu–virus).

Unit IV

Bacteriophages: Stages in the Lytic Life Cycle of a typical phage, Specificity of T4, T7, and lambda phage infection in E. coli, Prophage integration, induction, and excision. Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles. The lysogenic Cycle.

Suggested Readings:
1. Microbial Genetics by Maloy et al., Jones & Bartlett Publishers.
2. Molecular Genetics of Bacteria by Dale J.W., John Wiley & Sons.
3. Gene by Lewin, Oxford University Press.
4. Bacterial & Viral Genetics by Hayes W.
5. General Microbiology by Stanier, Ingraham, Wheelis & Painter.
6. Textbook of Microbiology by Dubey & Maheshwari.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Practical:
1. Isolation of plasmid DNA from *E. coli* and visualization by agarose gel electrophoresis.
2. Bacterial transformation with a plasmid containing a visible marker (e.g., GFP).
3. Induction of mutations in bacteria using UV light and observation of mutant colonies.
4. Study of conjugation in bacteria using a donor and recipient strain.
5. PCR amplification of a bacterial gene (e.g., antibiotic resistance gene).
6. Analysis of microbial mutants using simple phenotypic tests (e.g., sugar fermentation).
7. Demonstration of transduction using a safe bacteriophage model.
8. Simulation of gene mapping in bacteria using bioinformatics tools.