GURU NANAK COLLEGE (AUTONOMOUS)

(Affiliated to university of Madras and Accredited at A++ Grade By NAAC)
Guru Nanak Salai, Velachery, Chennai - 600042

SCHOOL OF SCIENCES

B.Sc., BIOTECHNOLOGY

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

Syllabus

(For the UG Batch of 2024-27 and thereafter)

LEARNING OUTCOME BASED CURRICULUM FRAMEWORK

1. PREAMBLE- About the Programme

Biotechnology is a branch of Applied Biology which incorporates the principles of all the disciplines of Science, Engineering, Commerce and Humanities, to develop and market products & technologies. Biotechnology aims towards societal issues, developing eco-friendly, biocompatible products to suit every living form upon this biosphere. Biotechnology connects the lacuna between Science, Humanities and Commerce. Biotechnology is the backbone for Circular Economy. Through Biotechnology the one industrial waste can be converted into another product, leading to mitigation of waste leading to pollution. Biotechnology supports for the crop and food resilience, clean energy and water, pharmaceutical product at low cost, leading to the social and economic equalities. Biotechnology caters to all the Sustainable goals addressed by UNO.

The B.Sc. Biotechnology offered at Guru Nanak College focuses upon inculcating the concept of sustainability and designed with a Multi-Disciplinary approach to suit academic and industrial requirements. The core subjects like Biochemistry, Microbiology, Bioprocess technology, Genetic Engineering, Bioinformatics, Environmental Biotechnology, Plant & Animal Biotechnology, Allied subjects like Chemistry, Bioinstrumentation, Genetics, Immunotechnology and the supportive electives like Creative careers, Green practice for sustainable life, are well chalked out for a holistic Student development to face the challenges in the field of Biotechnology.

There are concepts which explain to the students about the exclusive Indian Governmental norms adapted for Biotechnological based prototype/ product production and ethical commercialization. The students will be motivated to learn the etiquette to become bioentrepreneurs and have their own start-ups. At the end of second-year students are encouraged to take up internship and during the third year to take up a group project which would make them understand the problem statement and to find a solution through their knowledge gained.

The course completion enables students to be employed in both dry lab and wet lab jobs like Quality control officer in food, pharmaceutical, aquaculture and also in the other relevant jobs, prototype development, cosmetics & nutraceutical industries, fermentation industries, hospitals labs. Dry lab jobs like Patent field agent, Bioinformatics. Coaching for entrance exams like GAT- B, IIT-JAM, CUET are provided to students, who are interested in pursuing Post graduation in Central and State University.

2. Vision

To enable the students to be ready to fill the talent gaps in the field of Biotechnology particularly in the lateral emerging areas of Biotechnology.

3. Mission

1. To facilitate an encouraging and exciting environment to develop the scientific temper in students through a curriculum based on fundamental as well as advanced scientific knowledge.
2. To provide technical skills in the respective disciplines through conducting practical training including internship as well as project, this will hone the skills necessary to become a successful mathematician, physicist, chemist, biotechnologist and visual communication professional.
3. To inculcate interdisciplinary knowledge, elective subjects in various fields are offered, thereby providing an opportunity to the students to identify their interest towards a particular field and pursue the passion.

4. Program Educational Outcomes (PEOs)

PEO-1: Values of Life, Ethics & Social Concern

The graduates exhibit truth, loyalty, and love as integral moral principles, thereby contributing to a society characterized by enhanced well-being and fundamental goodness in behavior.

PEO-2: Employability & Entrepreneurship

The graduates apply analytical, logical, and critical problem-solving skills in professional contexts, elevating employability and cultivating entrepreneurial capabilities through upskilling.

PEO-3: Regional/National/Global Relevance & Competency

The graduates foster advanced analytical skills and a heightened appreciation for current Regional/National/Global perspectives, enabling informed and sustainable decision-making in a dynamic environment.

PEO-4: Skill Enhancement, Self-Directed & Lifelong Learning

The graduates independently engage in skill-based learning, utilizing infrastructure and opportunities for continuous upskilling, enabling self-evaluation and lifelong excellence attainment.

PEO-5: Research Skills & Innovation

The graduates proficiently apply scientific reasoning, fostering creativity, strategic thinking, and effective problem-solving skills. They demonstrate a core competency in generating innovative ideas for advancements and inventions.

5. Programme Outcomes

PO 1. Instil scientific and analytical reasoning to empower students towards critical thinking thereby enriching inter/multidisciplinary knowledge.
PO 2. Encourage self-regulated learning leading to problem-solving skills and adaptability.
PO 3. Incorporate experiential learning leading opportunities and engage in tangible situations to develop essential life skills.
PO 4. Enhance application skills by interconnecting academia and professional realm to achieve employability.
PO 5. Foster research abilities to address everyday challenges, make impactful contributions and participate in shaping a better future for the society.

6. Programme Specific Outcomes

PSO 1: Clarity in application of fundamental concepts for new technologies development related to Life Science.
PSO 2: Acquisitions suitable analytical skills.
PSO 3: Familiarised with the economic feasibility of the production of products sustainably.
PSO 4: Familiarised with IPR, Biosafety and Bioethical issues related to the field of Biotechnology
PSO 5: Attainment of professional status in the core and lateral fields of Biotechnology and to scale to Bioentrepreneurs

7. PEO – PO mapping

	PEO 1	PEO 2	PEO 3	PEO 4	PEO 5
PO 1	5	5	5	5	5
PO 2	4	5	5	5	5
PO 3	4	5	5	5	5
PO 4	4	5	5	5	5
PO 5	5	5	5	5	5

8. PO – PSO mapping

	PO 1	PO2	PO3	PO4	PO5
PSO 1	3	2	2	1	1
PSO 2	3	3	3	3	3
PSO 3	3	3	3	3	3
PSO 4	3	3	3	3	3
PSO 5	3	3	3	3	3

9. CHOICE BASED CREDIT SYSTEM (CBCS)

The College follows the CBCS with Grades under the Semester pattern. Each course is provided with a credit point based on the quantum of subject matter, complexity of the content and the hours of teaching allotted. This is done after a thorough analysis of the content of each subject paper by the members of the Board of Studies and with the approval of the Academic Council. Students are also offered a variety of Job oriented Elective, Multidisciplinary skill-based courses as part of the curriculum. Students can earn extra credits by opting for Massive Open Online Courses (MOOCs) and Certificate Courses.

The evaluation method under CBCS involves a more acceptable grading system that reflects the personality of the student. This is represented as Cumulative Grade Point Average (CGPA) and Grade Point Average (GPA) which are indicators of the Academic Performance of the student. It provides students with a scope for horizontal mobility and empowers them with the flexibility of learning at their convenience.

ELIGIBILITY FOR ADMISSION

Candidates admitted to the first year of the UG programme should have passed the higher Secondary Examinations (Academic or Vocational Stream) conducted by the Government of Tamil Nadu or an examination accepted as equivalent thereof by the Syndicate of the University of Madras. Students applying for the PG programme should have taken the UG degree in the relevant subject from a recognized university as per the norms of the University of Madras.

DURATION OF THE COURSE

The UG programme is of three years duration with six semesters and the PG programme is of two years duration with four semesters. The period from June to November is termed as the odd semester and the period from December to April is referred to as the even semester. Each semester must compulsorily have 90 working days before the students appear for the final End Semester Exam.

COURSE OF STUDY

The main course of study for the Bachelor's Degree shall consist of the following:

FOUNDATION COURSES
PART - I: Tamil/ Hindi /Sanskrit/French
PART - II: English

CORE COURSES
PART - III: Consisting of (a) Main subject (b) Allied Subjects (c) Elective subjects related to the main subject of study and project work.

PART – IV: Those who have not studied Tamil up to XII standard and have taken a non- Tamil language under Part – I, shall opt for Basic Tamil in the first two semesters.

Those who have studied Tamil up to XII standard, and taken a non -Tamil language under Part – I, shall opt for Advanced Tamil in the first two semesters.

Others, who do not come under either of the clauses mentioned above, can choose a Non-Major Elective (NME) in the first two semesters.

- Soft Skills (I, II, III & IV Semesters)
- Self-Study (Compulsory) Course (III Semester)
- Environmental Studies (IV Semester)
- Value Education (V Semester)
- Summer Internship (After IV Semester)

PART - V: Compulsory Extension Services

A Student shall be awarded one credit for compulsory extension service. A student must enroll in NSS / NCC /Sports & Games/ Citizen Consumer Club / Enviro Club or any other service organization in the College and should put in compulsory minimum attendance of 40 hours, which shall be duly certified by the Principal of the College. If a student lacks 40 hours compulsory minimum attendance in the extension services in any Semester, s/he shall have to compensate the same, during the subsequent Semesters.

COURSE STRUCTURE

- The UG programme consists of 15-19 Core courses with 3-4 credits for each paper, 3 Elective courses and 4 Allied courses with 4-5 credits for each paper in addition to 4 Soft Skill courses with two credits each. Internship as a compulsory component carries 2 credits.
- Internship training is a compulsory component for all the UG & PG programmes.

10. Consolidated Credit Structure for all the 3 years

		No. of Paper	**Credits**
Part I	Language	4	12
Part II	English	4	12
Part III	Core	16	63
	Allied	4	20
	Elective	3	14
Part IV	NME	2	4
	Soft Skills	4	8
	Self-Study (Compulsory) Course	1	2
	EVS	1	2
	Value Education	1	2
	Internship	1	2
Part V	Extension activity	1	1
Total			**142**

11. Credit Distribution for Each Semester

Semester I Course Component		Subject	Hrs/Week	Credit	Marks		Total
					Internals	Externals	
Part I	Language	Language–I: Tamil-I/ Hindi-I/ French-I/ Sanskrit-I	6	3	50	50	100
Part II	English	English–I	4	3	50	50	100
Part III	Core-I	Cell and Molecular Biology	5	5	50	50	100
	Core- II	Practical – I: Cell and Molecular Biology and Chemistry	6	3	50	50	100
	Allied-I	Chemistry	5	5	50	50	100
Part IV	Non-Major Elective-I	Basic Tamil-I /Advanced Tamil-I/ Department NME: Creative careers	2	2	50	50	100
	Soft Skills-I	Communication and Personality Development	2	2	50	50	100
Total			**30**	**23**			

Semester II Course Component		Subject	Hrs/Week	Credit	Marks		Total
					Internals	Externals	
Part I	Language	Language–II: Tamil-II/ Hindi-II/ French-II/ Sanskrit-II	6	3	50	50	100
Part II	English	English– II	4	3	50	50	100
Part III	Core- III	Biochemistry	5	5	50	50	100
	Core-IV	Practical-II: Biochemistry and Biotechniques and Bioinstrumentation	6	3	50	50	100
	Allied-II	Biotechniques and Bioinstrumentation	5	5	50	50	100
Part IV	Non Major Elective-II	Basic Tamil-II/ Advanced Tamil-II/ Department NME: Green practices for sustained life	2	2	50	50	100
	Soft Skills-II	Interview and Resume Writing	2	2	50	50	100
Total			**30**	**23**			

Semester III Course Component		Subject	Hrs/Week	Credit	Marks		Total
					Internals	Externals	
Part I	Language	Language–III: Tamil-III/ Hindi-III/ French-III/ Sanskrit-III	6	3	50	50	100
Part II	English	English–III	4	3	50	50	100
Part III	Core- V	Microbiology	6	5	50	50	100
	Core-VI	Practical-III: Microbiology and Genetics	6	3	50	50	100
	Allied-III	Genetics	6	5	50	50	100
Part IV	Soft Skills-III	Digital Proficiency and Multimedia Skills	2	2	50	50	100
	Self-Study (Compulsory Course) Can choose any one	Indian Heritage and Knowledge System/ Contemporary World and Sustainable Development	-	2	50	50	100
Total			**30**	**23**			

Semester IV Course Component		Subject	Hrs/Week	Credit	Marks		Total
					Internals	Externals	
Part I	Language	Language–IV: Tamil-IV/ Hindi-IV/ French-IV/ Sanskrit-IV	6	3	50	50	100
Part II	English	English–IV	4	3	50	50	100
Part III	Core- VII	Genetic Engineering	5	5	50	50	100
	Core-VIII	Practical-IV: Genetic Engineering and Immunology and Immunotechnology	6	3	50	50	100
	Allied-IV	Immunology and Immunotechnology	5	5	50	50	100
Part IV	Soft Skills-IV	Foundations of Quantitative Aptitude	2	2	50	50	100
	EVS	Environmental Studies	2	2	50	50	100
Total			**30**	**23**			

Semester V Course Component		Subject	Hrs/Week	Credit	Marks		Total
					Internals	Externals	
Part III	Core–IX	Bioprocess Technology	6	5	50	50	100
	Core–X	Molecular developmental Biology	6	5	50	50	100
	Core-XI	Bioinformatics and Biostatistics	6	5	50	50	100
	Core-XII	Practical-: Bioprocess Technology, Molecular developmental Biology, Bioinformatics and Biostatistics	6	3	50	50	100
	Elective – I	IDE	5	4	50	50	100
Part IV	Value Education	Value Education	1	2	50	50	100
	Internship	Internship	-	2	-	-	-
Total			**30**	**26**			
Semester VI **Course Component**		**Subject**	**Hrs/Week**	**Credit**	**Marks**		**Total**
					Internals	**Externals**	
Part III	Core-XIII	Plant and Animal Biotechnology	6	5	50	50	100
	Core-XIV	Biosafety, Bioethics and IPR	6	5	50	50	100
	Core-XV	Practical: Plant and Animal Biotechnology	6	3	50	50	100
	Elective - II	Environmental Biotechnology/ Food Biotechnology	6	5	50	50	100
	Elective - III	Project	6	5	50	50	100
Part V	Extension Activity	Participation in NSS/NCC/ Enviro Club, etc.	-	1	-	-	-
Total			**30**	**24**			
Grand Total				**142**			

EXAMINATION

Continuous Internal Assessment (CIA) will be for 50 percent and
End Semester Examination (ESE) will be for 50 percent.

CONTINUOUS INTERNAL ASSESSMENT (CIA)

Every semester will have a mid-semester examination which will be conducted on completion of 45 working days in each semester. A Model exam for three hours duration will be conducted on completion of 80 working days in each semester. For the courses coming under Part IV, ESE will be conducted in MCQ pattern. Internship credits will be given in semester V after verification of documents by the respective Heads.

The schedule for these tests is as follows:

CIA	Schedule	Syllabus Coverage
Mid Semester Examination	After **45** working days of the Semester	60%
Model Examination	After **80** working days of the Semester	95%

The components for the CIA (Theory & Practical's) are as follows:

Internal Components			
Assessment Type	**Nature**	**Maximum Marks**	**% of Weightage**
CIA	Mid Semester Examination	50	10
Model	Model Examination	100	10
	Assignment		10
	Class activities		15
	Attendance		5
Total			50

The class activity relates to a programme of accepted innovative techniques such as Seminar, Quiz, Portfolio creation, PowerPoint presentation, Objective tests, Role play, Group discussion, Case Study etc. The mode of evaluation of the class activity will be fixed before the commencement of the semester and an approval will be obtained from the Head of the programme/wing. The students will be informed of the various methods of evaluation once the semester begins. The students will be taken for Industrial visit periodically.

A record of all such assessment procedures will be maintained by the programme and is open for clarification. Students will have the right to appeal to the Principal in case of glaring disparities in marking. CIA marks for practical subjects will be awarded by the respective faculty based on the performance of the student in the model practical examination, observation notebook, submission of record books, regularity and attendance for the practical classes. The attendance particulars for practical classes will be maintained by the concerned faculty.

The marks for attendance will be awarded as per the following:

% of General Attendance	Marks Awarded
90-100	5
75-89	4
60-74	3
<60	0

END SEMESTER EXAMINATIONS (ESE)

After the completion of a minimum of 90 working days each semester, the End Semester Examinations will be conducted. Examinations for all UG and PG programmes will be held for all courses in November/December and April/May. Practical examinations will be conducted only during the end of the odd / even semester before, during or after the commencement of the theory exam. The schedule for ESE Practical's will be notified by the Controller of Examinations in consultation with the Dean (Academics)

12. Mode of Evaluation

METHODS OF EVALUATION		
Internal Evaluation	Mid Sem Exam (10)	50 Marks
	Model Exam (10)	
	Assignment (10)	
	Class activity (15)	
	Attendance (5)	
External Evaluation	End Semester Examination	50 Marks
Total		100 Marks

13. Method of assessment

Remembering (K1)	• The lowest level of questions requires students to recall information from the course content • Knowledge questions usually require students to identify information in the textbook. • Suggested Keywords: **Choose, Define, Find, How, Label, List, Match, Name, Omit, Recall, Relate, Select, Show, Spell, Tell, What, When, Where, Which, Who, Why**

Understanding (K2)	• Understanding off acts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. • The questions go beyond simple recall and require students to combined at altogether • Suggested Keywords: **Classify, Compare, Contrast, Demonstrate, Explain, Extend, Illustrate, Infer, Interpret, Outline, Relate, Rephrase, Show, Summarize, Translate**
Application (K3)	• Students have to solve problems by using / applying a concept learned in the classroom. • Students must use their knowledge to determine a exact response. • Suggested Keywords: **Apply, Build, Choose, Construct, Develop, Experiment with, Identify, Interview, Make use of, Model, Organize, Plan, Select, Solve, Utilize**
Analyze (K4)	• Analyzing the question is one that asks the students to breakdown something into its component parts. • Analyzing requires students to identify reasons causes or motives and reach conclusions or generalizations. • Suggested Keywords: **Analyze, Assume, Categorize, Classify, Compare, Conclusion, Contrast, Discover, Dissect, Distinguish, Divide, Examine, Function, Inference, Inspect, List, Motive, Relationships, Simplify, Survey, Take part in, Test for, Theme**
Evaluate (K5)	• Evaluation requires an individual to make judgment on something. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. • Students are engaged in decision-making and problem–solving. • Evaluation questions do not have single right answers. • Suggested Keywords: **Agree, Appraise, Assess, Award, Choose, compare, Conclude, Criteria, Criticize, Decide, Deduct, Defend, Determine, Disprove, Estimate, Evaluate, Explain, Importance, Influence, Interpret, Judge, Justify, Mark, Measure, Opinion, Perceive, Prioritize, Prove, Rate, Recommend, Rule on, Select, Support, Value**
Create (K6)	• The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem solving skills • Suggested Keywords: **Adapt, Build, Change, Choose, Combine, Compile, Compose, Construct, Create, Delete, Design, Develop, Discuss, Elaborate, Estimate, Formulate, Happen, Imagine, Improve, Invent, Make up, Maximize, Minimize, Modify, Original, Originate, Plan, Predict, Propose, Solution, Solve, Suppose, Test, Theory**

SEMESTER-I

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
Part: III	**Course Component:** Core-I
Course Name: Cell And Molecular Biology	**Course Code:**
Semester: I	**Marks:**100
Credits: 5	**Total Hours:** 75
THEORY	

COURSE OBJECTIVE:

To familiarize the concepts of cell structure, cell organelles, nucleic acids, gene expression and other cellular processes.

COURSE OUTCOMES:

1. Examine the structure and properties of prokaryotic and eukaryotic cells.
2. Analyse and explain the synthesis, structure and functions of cell organelles
3. Describe the structure, properties and functions of nucleic acids.
4. Analyse the types of cellular communication and to assess the phases of cell cycle and their role in cancer biology.
5. Accomplish a clear view on concept of central dogma.

UNIT I: Basic Biology of Cells (15 hrs)

Evolution of cells - Discovery of cells – Diversity of cells – General functions and properties of living cells – Formulation of cell theory - Modern Cell theory – Molecules of the cell and their chief functions – Basic Structure of bacterial, plant and animal cells – Differences between prokaryotic and eukaryotic cells.

UNIT II: Structure and functions of cell organelles (15 hrs)

Overview of cellular organization - Cell wall - Cell membrane: Fluid mosaic membrane model - Cell membrane Transport (Active: Symport, Uniport, Antiport and Passive transport) - Cytoplasm – Nucleus - Endoplasmic Reticulum (RER & SER) – Ribosomes – Golgi apparatus and dictyosomes - Mitochondria - Plastids - Lysosomes - Peroxisomes and glyoxysomes – Vacuoles and vesicles - Centrioles - Cytoskeleton - Microfilaments, Microtubules and Intermediate filaments – Pili, Cilia and Flagella - Cell Junctions: Adherent, gap and tight junctions.

UNIT III: An overview of Nucleic acids (15 hrs)

Discovery of Nucleic acids – Types of nucleic acids – Structure of DNA at primary and secondary levels – DNA Replication in prokaryotes and eukaryotes – Errors in DNA replication: DNA damages - DNA Proof reading methods – DNA repair mechanisms – RNA structure, types and functions.

UNIT IV: The central dogma of molecular biology (15 hrs)

The concept of central dogma – Gene expression and its importance - Transcription Unit - Transcription in prokaryotes and eukaryotes – Post transcriptional modification: RNA Processing - Capping, tailing and splicing (overview) - RNA editing – Genetic code - Translation in prokaryotes and eukaryotes - Post translational modification in eukaryotes – Protein folding, protein sorting and protein degradation.

UNIT V: Cell division, differentiation, communication, apoptosis & cancer (15 hrs)

Cell cycle – Cell cycle check points – Cell division by mitosis and meiosis – cell differentiation – Apoptosis and necrosis – Basics of cell-cell communication: Extra cellular matrix, Signalling molecules, receptors, types of cell signalling, steps in cell signalling, cell signalling pathways (types and chief functions only) - Formation of cancer cells - Differences between normal cell and cancer cells – Types of cancer cells.

PRESCRIBED BOOKS:

1. Devasena, Cell biology by, Oxford University Press, I Ed., 2012.
2. Geoffrey M. Cooper and Robert E. Hausman, Molecular approach to cell by, Oxford University Press, 7th Ed., 2018.

REFERENCE BOOKS:

1. Harvey Lodish (Author), David Baltimore (Author), Arnold Berk,, Molecular Cell Biology 3rd Ed., W H Freeman & Co (Sd).
2. Gerald Karp, "Cell and Molecular Biology Concepts and Experiments", Wiley 6th Edition, 2010.
3. Channarayappa, Molecular Biology, Universities Press, 2010.
4. The lives of a cell –A practical –Experimental Biology-A laboratory manual by Lewis Thomas.
5. Scott F. Gilbert and Michael J.F.Barresi, Developmental Biology, Oxford University Press,11th Ed., 2016

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=y623clAREHI&list=PL3993356C72C83C
2. https://www.youtube.com/watch?v=qOVkedxDqQo
3. https://www.youtube.com/watch?v=4qf1BSXn_tk
4. https://www.youtube.com/watch?v=89W6uACEb7M
5. https://www.youtube.com/watch?v=KIvBn6gfRgY

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	3	1	1
III	2	2	1
IV	2	2	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A – 12		**SECTION B - 7**	**SECTION C – 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	2	3
CO 2	3	3	2	2	3
CO 3	3	3	2	2	3
CO 4	3	3	2	2	3
CO 5	3	3	2	2	2
Ave.	3	3	2	2	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Comprehend the structure and properties of prokaryotic and eukaryotic cells.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4
CO2	Explain the synthesis, structure and functions of cell organelles	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4
CO3	Describe the structure, properties and functions of nucleic acids.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4
CO4	Elucidate the concepts and processes of central dogma.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5
CO5	Analyse the cellular communication and to assess the phases of cell cycle and their role in cancer biology.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
PART: III	**Course Component:** Core-II
Course Name: Cell and Molecular Biology and Chemistry	**Course code:**
Semester: I	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(a) Cell and Molecular Biology

COURSE OBJECTIVE:

To enable the students in operation of microscopes and analysis of different cell types

COURSE OUTCOMES:

1. Standard operation of microscopes in a perfect approach to stain, observe, identify and examine various types of cells.
2. Count, analyse and interpret the results with critique justification.

Experiments:

1. Description about the Compound Microscope: Principle and construction.
2. Preparation of buccal smear and examination of squamous epithelial cells
3. Counting of Red blood cell using Haemocytometer
4. Observation of plant tissues (onion peel) by safranin staining.
5. Identification of Mitotic stages by root squash of *Allium cepa* (onions)
6. Isolation and viewing of animal cells (Chicken liver)
7. Inspection of the biomolecules present in the plant cells by histochemical staining: Protein- Fast green staining, Carbohydrates- Potassium iodide - Iodine staining, Lipid- Sudan black and Metachromatin staining -Toluidine blue-O staining.
8. Viewing of yeast cells by methylene blue staining.

Demonstration Experiments:

1. Identification of meiotic stages using Grasshopper testes
2. Investigation of phytoplankton and zooplanktons in pond water using phase contrast microscope.

PRESCRIBED BOOK:

1. Gupta, Renu & Makhija, Seema & Toteja, Ravi. (2018). Cell Biology: Practical Manual.

REFERENCE BOOK:

1. Amit Gupta and Bipin Kumar Sati (2019.), Practical Laboratory Manual- Cell Biology

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=S7Ysd7DnVGU
2. https://www.youtube.com/watch?v=lz9RXhF1ys4
3. https://www.youtube.com/watch?v=hpb4cryMnvE
4. https://www.youtube.com/watch?v=5-ur7bWqlDQ
5. https://www.youtube.com/watch?v=e-yKVs_5AsA
6. https://www.youtube.com/watch?v=KPEWgcd987U
7. https://www.youtube.com/watch?v=zfXrd2AVvmE

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
PART: III	**Course Component:** Core-II
Course Name: Cell Biology and Chemistry	**Course code:**
Semester: I	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(b.) Chemistry

COURSE OBJECTIVE:

To learn about the basic preparation of samples, solutions, volumetric analysis and to learn about the working principles and handling of laboratory instruments.

COURSE OUTCOMES:

On completion of the course the students will be able to

1. Identify the strength of the solute in the give solution.
2. Analyse the pH of the given sample.
3. Describe the concept of normality, molarity, molality, equivalent weight and its related calculations.

Experiments:

Preparation of Standard Solutions

1. Preparations of solutions based on normality
2. Preparations of solutions based on molarity
3. Preparations of solutions based on percentage
4. Preparation of Buffer solutions with determined pH

Volumetric Analysis

1. Estimation of Sodium hydroxide using standard Sodium Carbonate.
2. Estimation of Hydrochloric acid using standard Oxalic acid.
3. Estimation of Ferrous sulphate using standard Mohr's salt
4. Estimation oxalic acid using standard Ferrous Sulphate.

Demonstration Experiment:

1. Estimation of hardness of water using EDTA
2. Systematic analysis of simple organic molecules.

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
PART: III	**Course Component:** Allied-I
Course Name: Chemistry	**Course code:**
Semester: I	**Marks:**100
Credits: 5	**Total Hours:** 30
THEORY	

COURSE OBJECTIVE:

To understand the basics of atomic orbitals, chemical bonds, hybridization and functional groups, thermodynamics, kinetics and catalysis, importance of Electrochemistry and Photochemistry.

COURSE OUTCOMES:

On completion of the course the students will be able to:
1. Explain the type of hybridization, electronic effect and mechanism involved in the organic reactions.
2. Apply various thermodynamic principles, systems and phase rule.
3. Apply/demonstrate the electrochemistry principles in corrosion, electroplating and fuel cells.
4. Identify the reaction rate, order for chemical reaction and explain the purpose of a catalyst.
5. Outline the various type of photochemical process.

UNIT – 1: Fundamental Concepts in Organic Chemistry (20 hrs)

Hybridization: Orbital overlap, hybridization and geometry of CH_4, C_2H_4, C_2H_2 and C_6H_6. Electronic effects: Inductive effect and consequences on Ka and Kb of organic acids and bases, electromeric , mesomeric, hyperconjugation and steric- examples and Reaction mechanisms: Types of reactions – aromaticity (Huckle's rule)- aromatic electrophilic substitution; nitration, halogenation, Friedel - Craft's alkylation and acylation. Heterocyclic compounds: Preparation, properties of pyrrole and pyridine. Stereochemistry: Classification- Optical isomerism: Optical activity, specific rotation, enantiomers, diastereomers, d, l and D, L notations of optical isomers – CIP rules – R and S nomenclature (molecules with one chiral carbon), optical isomerism of lactic and tartaric acid. Geometrical isomerism – cis and trans, syn-anti and E-Z nomenclature. Geometrical isomerism in maleic, fumaric acids

UNIT- 2: Thermodynamics (15 hrs)

Types of systems, reversible and irreversible processes, isothermal and adiabatic processes and spontaneous processes. Statements of first law and second law of thermodynamics. Carnot's cycle and efficiency of heat engine. Entropy and its significance. Free energy change and its importance (no derivation). Conditions for spontaneity in terms of entropy and Gibbs free energy. Relationship between Gibbs free energy and entropy.

UNIT – 3: Electrochemistry (15 hrs)

Galvanic cells - Standard hydrogen electrode - calomel electrode - standard electrode potentials - electrochemical series. Strong and weak electrolytes - ionic product of water - pH, pKa, pKb. Conductometric titrations - pH determination - buffer solutions and its biological applications - electroplating - Nickel and chrome plating - Types of cells - fuel cells - corrosion and its prevention.

UNIT – 4: Kinetics and Catalysis (15 hrs)

Order and molecularity. Integrated rate expression for I and II ($2A \rightarrow$ Products) order reactions. Pseudo first order reaction, methods of determining order of a reaction - Half life period – Catalysis - homogeneous and heterogeneous, catalyst used in Contact and Haber's processes. Concept of energy of activation and Arrhenius equation.

UNIT – 5: Photochemistry **(10 hrs)**

Grothus-Drapper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield - Hydrogen-chloride reaction. Phosphorescence, fluorescence, chemiluminescence and photosensitization and photosynthesis (definition with examples).

PRESCRIBED BOOKS:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house, Chennai, first edition, 2009.
2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006.
3. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S. Chand and Company, NewDelhi, twenty third edition, 2012.
4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007. – 112.

REFERENCES BOOKS:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house, Chennai, first edition, 2009.
2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006.
3. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012.
4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007. 5. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical Chemistry; Vishal Publishing Co., New Delhi, forty seventh edition, 2018.

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
Part: III	**Course Component:** NME-I
Course Name: Creative Careers	**Course code:**
Semester: I	**Marks:**100
Credits: 2	**Total Hours:** 30
THEORY	

COURSE OBJECTIVE:

The course intent to provide the students about the career opportunities available related to green industrial development.

COURSE OUTCOMES:

1. Career opportunities in food industry
2. Career opportunities in health care industry
3. Career opportunities in flavours and fragrance industry
4. Career opportunities in health care and nutraceutical industries
5. Bioindutsrial development related to face the challenges in today's society

Unit- I: Know your Food **(6 hrs)**

Health benefits of food, importance of food, Science of bread baking, chocolate, candies, jams, and Cheese (Indian and global variations), Indian fermented foods, probiotics foods, Importance South Indian meals

Unit-II: Health and Wellbeing **(6 hrs)**

Concept of health in religion and science, physical, physiological, psychological and reproductive, Indian traditional cooking utensils to impart wellbeing among humans

Unit-III: Flavours and Fragrances **(6 hrs)**

Flavours- Plants parts (leaf, flower, stem, root, fruit), Fragrance- Plants parts (leaf, flower, stem, root, fruit), and their applications

Unit-IV: Colours and Life **(6 hrs)**

Colour- Definitions, types: Natural and Synthetic, Sources of colour from Nature, Extraction of natural pigments, Application in textiles, paper making, Making water colour paint and in food

Unit-V: Social Innovation and Enterprise Development **(6 hrs)**

Innovation and enterprise development related to Indian society, economy, polity, Central and state government initiatives for innovation and entrepreneurship - self-help group, Micro-finance, marketing strategies of social enterprise

PRESCRIBED BOOKS:

- Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press (2010).
- S.C.BhatiaTextbook of Biotechnology, Atlantic Publishers & Dist. (2005).
- P.K.Gupta, Elements of Biotechnology, Rastogi Publications (2014).

E-LEARNING RESOURCES:

https://youtu.be/g_ZswrLFSdo
https://youtu.be/CVa_IZVzUoc
https://youtu.be/N2vXsnlHxcA
https://www.un.org/development/desa/youth/wp-content/uploads/sites/21/2020/10/WYR2020-Chapter1.pdf
https://www.indembassybern.gov.in/docs/Social-Entreprenuership-Report.pdf
YouTube: 3 E's of Sustainability: https://youtu.be/zx04Kl8y4dE?si=FrNZkD0zqMIzUCr8

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Career opportunities in food industry	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	Career opportunities in health care industry	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Career opportunities in flavors and fragrance industry	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	Career opportunities in health care and nutraceutical industries	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	Bioindutsrial development related to face the challenges in today's society	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-III
Course Name: Biochemistry	**Course Code:**
Semester: III	**Marks:**100
Credits: 5	**Total Hours:**75
THEORY	

COURSE OBJECTIVE:

To understand the core principle, Laboratory skills, integration of knowledge, Critical thinking to analyze experimental data, evaluate scientific literature and solve biochemical problem effectively.

COURSE OUTCOMES:

1. Compile the principles of bioenergetics, metabolism and disorder of carbohydrates
2. Compile the principles of bioenergetics, metabolism and disorder of proteins.
3. Compile the principles of bioenergetics, metabolism and disorder of lipids.
4. Compile, classify the enzymes, evaluate factors influencing enzyme activity and analyze enzyme kinetics and also understand the types and applications of porphyrins
5. Interpret the biochemical basis of vitamin and mineral deficiencies in health management.

UNIT 1 CARBOHYDRATES (15 hrs)

Carbohydrates: occurrence, properties, classification, functions – monosaccharide, oligosaccharides and polysaccharides; General properties with reference to glucose, anomer, epimer, and mutarotation. Carbohydrate Metabolism: Glycolysis (aerobic and anaerobic), TCA cycle - Electron Transport Chain, Gluconeogenesis, Carbohydrate metabolic disorder-Diabetes Mellitus.

UNIT II AMINO ACIDS, PROTEINS AND NUCLOETIDES (15 hrs)

Amino acids- Properties and classification based on functional groups. Essential and Non -essential amino acids. Proteins - Classification based on shape, solubility, chemical composition, Properties and functions. Structure overview - Primary, Secondary, tertiary and quaternary. Biosynthesis of amino acids (Arginine) and Urea Cycle. Protein metabolic disorder- Kwashiorkor and Maramus.

UNIT III LIPIDS , HORMONES (15 hrs)

Classification and function of lipids-. Fatty acids- classification– saturated fatty acids, unsaturated fatty acids. Essential and non-essential fatty acids. Physical and Chemical properties- emulsification, saponification number, rancidity, acid number, iodine number and Reichert – Meissl number. Lipid metabolic Lipid metabolism: Synthesis and β- oxidation of Palmitic acid, disorder-fatty liver. Hormones types and biological significance.

UNIT IV ENZYMES AND VITAMINS (15 hrs)

Enzyme - Classification, Nomenclature, and functional classification based on reaction type (e.g., oxidoreductases, transferases, hydrolases, lyases, isomerases, ligases) Enzyme Commission (EC) numbering system, Active sites and co-factors, Factors affecting enzyme activity (pH, temperature, and substrate concentration); Vitamin B2 and Folic Acid as cofactor; Enzymes involved in Nucleotide synthesis: PRPP Synthetase, HGPRT, Thymidine kinase, Enzyme Kinetics: Michaelis-Menten kinetics.

UNIT V PORPHYRINS (15 hrs)

Porphyrin compounds: Definition, Types (Properties and structural importance): Animal pigment (Melanin and Hemoglobin), Plant pigment (Chlorophyll), Other porphyrin compounds: Vitamin B12, Secondary metabolites- Properties, Source, types, biological significance: Alkaloids, Phenolic compounds, Terpenoids, Carotenoids.

PRESCRIBED BOOKS:

1. Albert Lehninger, David Nelson, Michael Cox, Principles of Biochemistry; W.H.Freeman,2000.
2. Donald Voet, Judith G.Voet, Charlotte W.Pratt, Fundamentals of Biochemistry: Life at the molecular level, Wiley, 5th Ed., 2016

REFERENCE BOOKS:

1. J.L.Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry, S.Chand Publishers, 7th Ed.,2006.
2. Satyanaryana.U, Essentials of Biochemsitry, New India Book Agency, 2nd, 2008.
3. T.Devasena, Biomolecules, MJP Publishers, Ist Ed., 2010.
4. Donald Voet, Judith G.Voet, Biochemistry, Vol. 1: Biomolecules, Mechanisms of EnzymeAction, and Metabolism, Wiley Publishers, Ist Ed., 2003.
5. V.K. Ahluwalia, Biomolecules Chemistry of Living System, Manakin Press, 2015.
6. MN Chatterjea, Textbook of Medical Biochemistry, 8th Edition
7. Deb AC. 2016. Fundamentals of Biochemistry. 7th edition, NCBA Publishers, New Delhi..
8. Jain JL, Sunjay Jain and Nitin Jain. 2018Fundamentals of Biochemistry. Updated edition. 2020. S.Chand Publishers, New Delhi.
9. Poonam Agarwal. 2020. Review of Biochemistry. 5th edition. CBS Publishers, New Delhi.
10. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 2003. Harper's Illustrated Biochemistry, 26th edition, McGraw-Hill Medical Publishers, New York.
11. Vasudevan DM. 2018. Biochemistry. 9th edition. Aypee Brothers Medical Publishers, New Delhi.

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E-LEARNING RESOURCES:

1 1. https://www.pdfdrive.com/biochemistry-books.html
2 https://www.pdfdrive.com/biochemistrystrayer-e25312085.html 13
3 https://www.youtube.com/watch?v=8qij1m7XUhk
4 https://www.youtube.com/watch?v=rdF3mnyS1p0
5 https://www.youtube.com/watch?v=FmafhSMv0e0
6 mod13.pdf (nptel.ac.in)

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	2	1	1
II	2	1	1
III	2	1	1
IV	3	2	1
V	3	2	2
TOTAL	**12**	**7**	**6**
SECTION A – 12		**SECTION B - 7**	**SECTION C – 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	2	3	3	3
CO 5	2	3	3	3	3
Ave.	2.8	2.8	3	3	3

PSO-CO-question paper mapping

CO No:	COURSE OUTCOME	PSOs ADDRESSED	COGNITIVE LEVEL (K1 to K6)
CO1	To compile the principles of bioenergetics, metabolism and disorder of carbohydrates	PSO1,PSO2	K1,K2,K3.
CO2	To compile the principles of bioenergetics, metabolism and disorder of proteins.	PSO1,PSO2,PSO3	K1,K2,K3.
CO3	To compile the principles of bioenergetics, metabolism and disorder of lipids,types and importance of hormones.	PSO1,PSO2,PSO3	K1,K2,K3.
CO4	To compile classify the enzymes, evaluate factors influencing enzyme activity and analyze enzyme kinetics and also interpret the biochemical basis of vitamin, daily requirement and deficiencies in health management	PSO1,PSO3,PSO4	K1,K2,K3,K4
CO5	To understand the types and applications of porphyrins	PSO1,PSO2PSO4,PSO5	K1,K2,K3

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core- IV
Course Name: Biochemistry and Biotechniques and Bioinstrumentation	**Course code:**
Semester: III	**Marks:**100
Credits:3	**Total Hours:** 30
PRACTICAL	

(a.) CORE IV - PRACTICAL - II: BIOCHEMISTRY

COURSE OBJECTIVE:

To understand and demonstrate detection, quantification of biomolecules.

COURSE OUTCOMES:

1. Integrate the acquired knowledge and skills from various experiments to understand the broader principles of biochemistry.
2. Demonstrate a holistic understanding of the role of biochemical analysis in advancing scientific knowledge and applications in diverse fields.
3. Develop critical thinking skills in the interpretation of qualitative and quantitative biochemical analysis results.
4. Apply acquired knowledge and skills to real-world scenarios, emphasizing the importance of biochemistry in various fields, including food and therapeutics.
5. Develop proficiency in performing Thin-Layer Chromatography (TLC) and to identify the antioxidant mechanism.

Volumetric Analysis:

a. Estimation of ascorbic acid using 2, 6 – dichlorophenol indophenol as link solution.

Qualitative analysis:

a. Qualitative analysis of carbohydrates- glucose, fructose, lactose and sucrose.
b. Qualitative analysis of amino acids – arginine, cysteine, tyrosine and tryptophan.
c. Detection of the presences of Catalase in potato extract.

Quantitative Analysis:

a. Colorimetric estimation of protein by Lowry's method and Biuret method.
b. Colorimetric estimation of Carbohydrate by Anthrone/ DNS method.
c. Colorimetric estimation of lipid by Vanillin method

Demonstration Experiments:

● Demonstration of presences of aflatoxin by TLC (to emphasise Food Biochemistry).

● Demonstration of extraction of caffeine and antioxidant property by DPPH method (To emphasise the importance of Therapeutic Biochemistry of metabolites).

REFERENCE BOOKS:

1. David Plummer, An introduction to practical Biochemistry, Tata McGraw-Hill Education, 1998.
2. Sowbhagya Lakshmi and Divya ShanthiD'Sa, An easy guide for practical Biochemistry by,Jaypee Brothers Medical Publishers (P) Ltd., 2010.
3. T.Devasena, Techniques in Biochemistry, Ahuja Publishing House, 2010.
4. G. Devala Rao, A manual of practical biochemistry, Birla Publications (Regd) Pvt Ltd., 2015.
5. Order_Revised_Manual_Mycotoxins_04_12_2020.pdf (fssai.gov.in)
6. separation-science-extraction-of-caffeine-laboratory-protocol-updated.pdf (kcl.ac.uk)

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component**: Core-IV
Course Name: Biochemistry and Biotechniques and Bioinstrumentation	**Course code:**
Semester: III	**Marks:**100
Credits:3	**Total Hours:**30
PRACTICAL	

(b.) CORE IV - PRACTICAL - II: BIOTECHNIQUE AND BIOINSTRUMENTATION

Course Objectives:

To introduce fundamental principles and working of basic analytical instruments used in a biological laboratory

Course Outcomes:

1. Demonstrate the basic principles and working of Compound and Phase Contrast Microscope
2. Perform the techniques of centrifugation and chromatography for studying cells and separation of biomolecules
3. Apply different solvent extraction techniques for isolating bioactive compounds
4. Comprehend the principle of measuring the concentrations of biomolecules by spectrophotometer
5. Understand the various forms of DNA with the help of Agarose Gel Electrophoresis

Experiments:

1. Observation of photosynthetic algae in pond water using compound and phase contrast microscope.
2. Separation of plant subcellular organelle by differential centrifugation technique
3. Separation of blood cells based on sucrose density gradient centrifugation
4. Extraction of plant compounds by using methanol extraction and Soxhlet Apparatus
5. Separation of Biomolecules by Thin Layer Chromatography and demonstration of fluorescence pigments.
6. Separation of Biomolecules by column chromatography
7. Spectroscopic analysis of Biomolecules using UV-Visible spectroscopy.
8. Estimation of proteins from food sample (egg) by Colorimetric method and UV-Spectrophotometer.

Demonstration Experiments:

1. Demonstration of salivary amylase activity using pH meter.
2. Visualization of various DNA fragments by using Agarose Gel Electrophoresis (nicked, linear, super coiled and circular single strand DNA, degraded DNA bands).

REFERENCE BOOKS:

1. J. Ninfa and D. P. Ballou, Fundamental Laboratory Approaches for Biochemistry and Biotechnology, 1998 2nd Edition Wiley.
2. Sharms, “Instrumental Methods”, S Chand & Co
3. Principles & Practice of Bioanalysis, Richard F. Venn.

E-LEARNING RESOURCES:

1. www.labinapp.com
2. www.labster.com
3. www.onlinelabs.in
4. https://li.wsu.edu

Programme: B.Sc., Biotechnology	**BATCH:**2024-27
PART:III	**COURSE COMPONENT:** Allied-II
COURSE NAME: Biotechniques and Bioinstrumentation	**COURSE CODE:**
SEMESTER: III	**MARKS:**100
CREDITS:5	**TOTAL HOURS:**75
Theory	

COURSE OBJECTIVE:

To understand the good and suitable practical knowledge of Biotechnology lab.

COURSE OUTCOMES:

1. Perform experiment and analysis employing microscopy.
2. Demonstrate the separation of biomolecules with the help of Centrifugation
3. Perform various chromatography techniques for the separation of different biomolecules
4. Analyze and quantify biomolecules employing Colorimetric and Spectroscopic principles
5. Study the different biomolecules with electrophoresis and electrophysiology principles

UNIT 1: Principle, instrumentation, types and applications of Microscopy (15 hrs)

Microscopes – Magnification and resolution power - Micrographs – Microscope lenses and types - Simple microscopes – Compound microscopes — Basic operation procedures of a Bright field microscope – Types of microscopes - Dark field microscopes - Phase contrast microscopes – Fluorescent microscopes – Electron microscope (SEM & TEM) – Applications of microscopes and cell architecture studies.

UNIT II: Principle, instrumentation, types and applications of Centrifugation (15 hrs)

Forces involved in centrifugation: Gravitational force, centrifugal force and centripetal force. Principles of sedimentation – Stroke's law - Factors influencing centrifugation – Rotors used in centrifuges -Types of centrifuges – Preparative centrifugation – Analytical centrifugation – Applications of centrifugation in separation of cells and molecules.

UNIT III: Principle, instrumentation, types and applications of Chromatography (15 hrs)

Stationary phase – Mobile phase – Types of separation mixtures – Capillary action - Partition coefficient – Distribution coefficient – Rf Value - Paper chromatography – Thin layer chromatography –- Column chromatography – Size exclusion chromatography - Ion exchange chromatography – Affinity chromatography – High pressure liquid chromatography – Gas liquid chromatography.

UNIT IV: Colorimetry and Spectroscopy (15 hrs)

Colorimeter: Principles, types and application. Spectroscopy: Overview. Principles, instrumentation and applications of UV-Visible spectroscopy – Overview and applications: Fluorescence spectroscopy, Atomic absorption spectroscopy, Gas Chromatography - Mass Spectrometry (GC-MS).

UNIT V: Principle, instrumentation, types and applications of Electrophoresis and Electrophysiology techniques (15 hrs)

Principle, instrumentation and application: Agarose gel electrophoresis and pulse field electrophoresis, PAGE: SDS Polyacrylamide gel electrophoresis and 2-gel, Basics of electrophysiology: clamp technique, Patch clamp technique (applications only).

PRESCRIBED BOOKS:

1. Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th Ed) Cambridge University Press
2. David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd Ed), Wiley-Blackwell

REFERENCE BOOKS:

1. David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H.Freeman
2. Rodney F. Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques, (2nd Ed),
3. Prentice Hall
4. Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=VpiqscrcbME
2. https://www.youtube.com/watch?v=U5N2uxHNzxg
3. https://www.youtube.com/watch?v=Dq5JgsxJpTY
4. https://www.youtube.com/watch?v=W0oacysFTko
5. https://www.youtube.com/watch?v=1uPyq63aRvg
6. https://www.youtube.com/watch?v=SsIYDEma_cU
7. https://www.youtube.com/watch?v=2rYmUxqz3jo&list=PLFD540BF4995B4469
8. https://www.youtube.com/watch?v=x8one-B_Y1w
9. https://www.youtube.com/watch?v=sOb9b_AtwDg

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	3	1	1
III	2	2	1
IV	2	2	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	2	2	3
CO 5	3	3	3	3	3
Ave.	3	3	2.6	2.8	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Perform experiment and analysis employing microscopy	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4
CO2	Demonstrate the separation of biomolecules with the help of Centrifugation	PSO1, PSO2, PSO3, PSO4, PSO5	K2, K3, K4, K5
CO3	Perform various chromatography techniques for the separation of different biomolecules	PSO1, PSO2, PSO3, PSO4, PSO5	K3, K4, K5
CO4	Analyze and quantify biomolecules employing Colorimetric and Spectroscopic principles	PSO1, PSO2, PSO3, PSO4, PSO5	K3, K4, K5
CO5	Study the different biomolecules with electrophoresis and electrophysiology principles	PSO1, PSO2, PSO3, PSO4, PSO5	K3, K4, K5

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
PART: III	**Course Component:** NME-II
Course Name: Green practices for sustained life	**Course code:**
SEMESTER: II	**Marks:**100
CREDITS: 2	**Total Hours:** 30
Theory	

COURSE OBJECTIVE:

To teach students the concept of value addition of products, waste reduction and to emphasis on Biobased economy.

COURSE OUTCOMES:

1. Identify the challenges of linear economy and also to identify the opportunity of circular economy.
2. Gain knowledge about circularities and their applications.
3. Discuss about the affordable, reliable and sustainable products.
4. Recall tapping of alternative energy resources
5. Highlight the government green policies.

Unit- I: Resource planning **(6 hrs)**

Types of waste and product development: domestic waste (kitchen waste), industrial (effluents), -waste (Integrated circuit chip- gold extraction), medical (placenta- ointment), agriculture (paddy straw)

Unit- II: Cleaner production systems **(6 hrs)**

Need for cleaner production system, input material change and process modification - benefits, sustainable product innovation

Unit- III: Biomimetics

Wind turbine- school of fish, Building construction- termite hill, prosthetic foot- Cheetah, Night vision camera- Prawn, Aeroplane - Birds, Self -cleaning sheets- Louts leaf effect

Unit- IV: Alternative Energy **(6 hrs)**

Renewable resources-based energy: Wind, Solar, Hydro, Bioenergy: Biofuel, Algal based fuel

Unit- V: The 3 E's for Sustainability **(6 hrs)**

Environment sustainability, fundamental of ecology, inter-relationship of ecosystem, factors influencing sustainability eco-system, economic sustainability, economy sustainability: economy and environment, social equity, different between social equity and social equality, promotion of social equity

REFERENCE BOOKS:

1. Iris Lewandowski. (2018). Bioeconomy Shaping the Transition to a Sustainable, Biobased Economy. ISBN 978-3-319-68151-1 ISBN 978-3-319-68152-8 (eBook).
2. Purvis, B., Mao, Y. & Robinson, D. Three pillars of sustainability: in search of conceptual origins. Sustain Sci 14, 681–695 (2019). https://doi.org/10.1007/s11625-018-0627-5

E-LEARNING RESOURCES:

1. Circularity beyond sustainability: circular business models drive resilient growth | FT Moral Money (youtube.com)
2. Making bioeconomy circular: How far can circular economy principles be applied to the bioeconomy? (youtube.com)
3. The BLOOM Documentary about Bioeconomy (youtube.com)

4. Bioplastic from Bacteria - BLOOM Videoseries (youtube.com)
5. Rethinking circularity in bioeconomy (youtube.com)
6. The Global Circularity Gap Report 2023 (youtube.com)
7. https://eprints.whiterose.ac.uk/136715/7/Purvis2018_Article_ThreePillarsOfSustainabilityIn.pdf
8. YouTube: Social Entrepreneurship: https://youtu.be/w0tBYdXNg0A?si=S3HGK-wPkDQkqp62

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	To identify the challenges of linear economy and also to identify the opportunity of circular economy	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	To gain knowledge about circularities and their applications	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	To discuss about the affordable, reliable and sustainable products	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	To recall tapping of alternative energy resources	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	To highlight the government green policies	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024 - 27
Part: III	**Course Component:** Core-V
Course Name: Microbiology	**Course Code:**
SEMESTER: III	**Marks:** 100
CREDITS: 5	**Total Hours:** 75
THEORY	

COURSE OBJECTIVE:

To familiarise the basics of Microbiology, sterilisation, culture handling, microbial growth, antibiotics mechanism, application of microbiology in agriculture, environmental pollution degradation, biomolecules from microbiology, role of microbes in waste water to portable water.

COURSE OUTCOMES:

1. Familiarize with the evolution of microbes and their classification.
2. Apply the various sterilization techniques.
3. Classify the microbes and demonstrate the various biochemical test to identify the microbes.
4. Identify and interpret the microbial interactions.
5. Relate the application of microbes in the field of agriculture and plant growth, waste water, bioremediation.

Unit I: Introduction to Microbes and its classification and Indian Microbial Institute **(15 hrs.)**

History of Microbiology and importance of Microbiology; Branches of Microbiology; About: ICMR, Indian marine research institutes, Whitakaer classification, Ultrastructure of bacteria; Classification of Microbes based upon: shape, Cell wall, nutritional requirements, Optimum growth temperature, primitiveness: Archaebacter and Eubacter; General properties of: Virus, fungi, protozoa, algae.

Unit II: Sterilization and culture techniques **(15 hrs.)**

Sterilization: mechanism and types: radiation, ultra- sonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis, fumigation; Media: Properties and types; Bacterial culturing techniques; Bacterial growth, bacterial growth curve determination; calculation of generation time and biochemical and molecular identification of bacteria.

Unit III: Microbial disease **(15 hrs)**

Microbial interactions Mutualism, Commensalism, symbiotic association, saphrophytic and parasitic; El Nino and La Niῆa effect and occurrence of microbial infections, Microbial pathogenesis and disease diagnosis: Bacterial disease- *S. aureus*, *Streptococcus pyogenes*, *M.tuberculosis*, *Klebsiella pneumonia*, Viral- *Adeno viral infection*, Small pox, Arbo virus, Hepatitis-B, Fungal- Cutaneous, sub cutaneous, systemic infections, Yeast- Candida albicans, Parasite- Plasmodium, tape worm infection, amoebiosis; Marine pathogen- *Vibrio harveyi*.; Antibiotics: Classification and mechanism.

Unit-IV: Food, agricultural and Marine microbiology **(15 hrs)**

Benefits of microbes: Probiotics, SCP, Microbial based food products: Curd, Cheese, kimchi, sauerkraut, bread, Microbial food spoilage of raw and cooked foods, methods of food preservation, HACCP, Permissible limits of Microbes in water, milk, sea food, Microbial food colors and flavours, food borne diseases*: E.coli*, *V.cholera*, *S. typhi*, Hepatitis-A virus.

Agricultural Microbiology: Importance of rhizosphere bacteria: Rhizobium spp, Azolla, Azospirillum, Cyanobacteria as biofertilizer, Mycorrhizal fungi importance: Ecto and Endormycorrhizae. Plant diseases: Rice Blight disease of rice- Xanthomonas oryzae, Sugarcane red rot- Fusarium verticillioides.

Unit V: Environmental and marine microbiology (15 hrs)

Microbial Bioindicators to determine for water quality, sewage and waste water treatment purification, Microbial ore leaching; Biosurfacants from Microbes, Marine Bacteria: Examples (emphasizing upon beneficial bacteria) and Commercial products from marine microbes: Nutraceuticals, therapeutic, diagnostic compounds; Quorum sensing of bacterial biome in squid; Role of marine bacteria in: Bioremediation: Biodegradation, Bioagumentation, Biofouling.

REFERENCE BOOKS:

1. Pelezar, Chan, "General Microbiology"– Krieg Tata McGraw Hill Publications, 2007.
2. Ananthanarayan and Paniker's Textbook of Microbiology, 10th Ed., UniversitiesPress. 2017.
3. Prescott, Harley and Klein, "Microbiology", McGraw Hill publications, Fifth edition,2003.
4. Jacquelyn G.Black, "Microbiology -Principles and Explorations" Wiley publications2008.
5. VarunShastri, Microbes by Isha Books, Ist Ed., 2006.
6. Microbiology Laboratory by V.R. Ramamurthy, Black Prints India Inc., Ist Ed., 2013.
7. Handbook of Food Technology by NIIR, National Institute of Science publication.
8. Hans-Joachim Jördening, Josef Winter, "Environmental Biotechnology: Concepts and Applications", Wiley, 2006.
9. Chandrawati Jee, Shagufta,"Environmental Biotechnology", APH Publishing, 2007.
10. Bacterial Biotechnology by Bhattacharjee& Sridhar, Wisdom Press.
11. Environmental Toxicology and Biotechnology by S. K. Dubey& S. Ghose, DominantPublishers & Distributors (P) Ltd., 2009.
12. Environmental Biotechnology by Scragg, Oxford.

E-Learning Resources:

1. https://www.youtube.com/watch?v=iDVq2etiknU
2. https://www.youtube.com/watch?v=qZXOILsh9ro
3. https://www.youtube.com/watch?v=zDmP14twN8g&t=77s
4. https://www.youtube.com/watch?v=y_EhCERWzfs
5. https://www.youtube.com/watch?v=Et1v8EQP10U

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	2	2	1
III	2	1	2
IV	2	2	1
V	3	1	1
TOTAL	12	7	6
SECTION A – 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	2	2	2	2	2
CO 3	3	1	1	1	2
CO 4	3	1	2	1	2
CO 5	3	3	3	1	3
Ave.	2.8	2	2.2	1.8	2.4

PSO-CO-question paper mapping

CO No:	COURSE OUTCOME	PSOs ADDRESSED	COGNITIVE LEVEL (K1 to K6)
CO1	Familiarize with the evolution of microbes and their classification	PSO1, PSO2, PS05	K1, K2, K3, K4, K4, K5, K6
CO2	Apply the various sterilisation techniques	PSO1, PSO2	K1, K2, K3, K4, K4, K5, K6
CO3	Classify the microbes and demonstrate the various biochemical test to identify the microbes	PSO1, PSO2, PSO3	K1, K2, K3, K4, K4, K5, K6
CO4	Identify and interpret the microbial interactions	PSO1, PSO2, PSO3	K1, K2, K3, K4, K4, K5, K6
CO5	Relate the application of microbes in the field of agriculture and plant growth, waste water, bioremediation	PSO1, PSO2, PSO3, PSO5	K1, K2, K3, K4, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
Part: III	**Course Component:** Core-VI
Course Name: Microbiology and Genetics	**Course Code:**
Semester: III	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(a) CORE VI: PRACTICAL – III: MICROBIOLOGY

COURSE OBJECTIVES:

To familiarize the basic microbiology techniques and also apply the concepts to microbiology in food, agriculture, mitigation of waste.

COURSE OUTCOMES:

1. Perform staining techniques for bacterial identification
2. Identify the bacteria based upon the various biochemical properties.
3. Isolate the bacteria from different types of samples such as air, water and soil.
4. Isolate PGPB
5. Screening of industrial important microbes.

Experiments:

1. Staining protocols
   - Simple staining
   - Differential staining (Gram's staining: Gram positive bacteria: Cocci in chains, cocci in clusters, Bacilli spp., Gram negative strain: *E.coli*)
   - Special staining (Spore, Capsular and Metachromatic staining)
2. Serial dilution and calculation of colony forming units
3. Isolation of bacteria, identification and confirmation of *E.coli* by biochemical characterization techniques from sewage sample.
4. Isolation of plant growth promoting bacteria from rhizosphere soil sample (confirmphosphatase, siderophore).
5. Isolation of probiotic bacteria (aerobic and anaerobic) from curd sample
6. Screening of enzyme producing bacteria: Starch hydrolysing bacteria
7. Demonstration of permissible limits of total bacterial count in sea food sample.
8. Fungus identification by - Lactophenol cotton blue staining method.
9. Antibiotic sensitivity test: Disc diffusion method.
10. Culture on selective media and identification of fluorescent bacteria.

Demonstration Experiments:

1. Demonstration of Autoclave and hot air oven for sterilization of glasswares and medium.
2. Water quality test-MPN test
3. Open plate technique.
4. Demonstration of fungal colonies

REFERENCE BOOKS:

1. TSR manual
2. Bergey's Manual of Systematic Bacteriology, David Hendricks Bergey, 9th Ed.,
3. Practical Microbiology - A Laboratory Manual, Senthilkumar Balakrishnan, Zothansanga, Senbagam Duraisamy, Guruswami Gurusubramanian, Panima Publishing Corporation, New Delhi, India, 2013.
4. General Microbiology Laboratory Manual, Biology 490, Sam R. Zwenger, Ph.D., 2nd Ed.

E-LEARNING RESOURCES:

1. How to Calculate CFU per ml of Bacterial Sample? in 3 Steps || cfu/ml in Microbiology (youtube.com)
2. 2.Biochemical Tests for Bacterial Identification (Part-1)_TSI, MIU, MR-VP, Lysin, Urea, Citrate (youtube.com)
3. 3.Primary screening of antibiotic producing organisms by crowded plate techniques (youtube.com)
4. Bacteriophage Titer Lab. (youtube.com)

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
Part: III	**Course Component:** Core-VI
Course Name: Microbiology and Genetics	**Course Code:**
Semester: III	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(b.) CORE VI– PRACTICAL – III: GENETICS

COURSE OBJECTIVE:

To demonstrate genetic principles practically and to culture the genetic model organisms on their own and witness the pattern of inheritance and phenotypic expression of genetic traits.

COURSE OUTCOMES:

1. Compare dominant and recessive traits of pea plant
2. Demonstrate multiple alleles and codominance
3. Identify chromosomal disorders using human karyotyping photomicrographs
4. Observe different developmental stages of drosophila

Experiments:

1. Observation of seven characteristics of Pea plant using photomicrographs
2. Demonstration of Co-dominance and multiallelism by ABO blood grouping.
3. Preparation of pedigree chart using ABO blood group.
4. Culture and maintenance of *Drosophila melanogaster* and reporting of the developmental stages (to record of time duration of larval stages to pupa and pupa to adult).
5. Examination of polyploidy using onion root tip squash
6. Staining and identification of Giant chromosomes from *Chironomous* larvae/ *Drosophila* larvae salivary glands.
7. Classification of different types of Human chromosomes (Metacentric, submetacentric, Telocentric and acrocentric) by Photomicrographs.
8. Study of dermatoglyphics of fingers and palm, as family case study.

Demonstration Experiments:

1. Microphotograph study of mutants of Drosophila: Eye, wing- mutations, mutations related to thoracic body structures, antenna-pedia complex.
2. Identification of chromosomal abnormalities using photomicrographs of karyotypes: Down's syndrome, Turner's and Klinefelter syndrome.
3. Expression of recombination using *Portulaca grandiflora* (button rose plant).

REFERENCE BOOKS:

1. Dr. P.S.Verma and V.K.Agarwal, Genetics, S.Chand Publishers, 2010.
2. Daniel L.Hartl, Bruce J.Cochrane, Genetics, Analysis of Genes andgenomes, Jones and Bartlett Publishers, 6th Ed., 2005.
3. Gardner , Simmons and Snutad Principles of Genetics, John Wiley & Sons Ltd., 8th Ed., 2005.
4. Richard Dawkins, The Selfish Gene, Oxford University Press, 4th Ed., 2016.
5. Jocelyn E. Krebs (Author), Elliott S. Goldstein (Author), Stephen T.Kilpatrick (Author) Lewin's Genes XII, Jones & Bartlett Learning; 12th Ed., 2017.
6. Steve Olson, Mapping Human History: Genes, Race and our common origins, Mariner Books; First Ed, 2003.
7. Sharma & Chakraborty, A Textbook of Developmental Genetics, Wisdom press. 2013.
8. Narain & Naha, Handbook of Heredity & Genetics, Wisdom Press, 2012.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=JJEJmDzrZPE
2. https://www.youtube.com/watch?v=mBq1ULWJp_M
3. https://www.youtube.com/watch?v=0bfpOhbKEAk&t=8s
4. https://www.youtube.com/watch?v=mh7i3nhzXzk
5. https://www.youtube.com/watch?v=Dzt3XdSZ1eI
6. https://www.youtube.com/watch?v=YXEdut0aKF8
7. DBT-Life-Science-Protocol-Manual.pdf (indiabioscience.org)

Programme: B.Sc., Biotechnology	**Batch:** 2024 – 27
Part: III	**Course Component:** Allied-III
Course Name: Genetics	**Course Code:**
SEMESTER: III	**Marks:** 100
CREDITS: 5	**Total Hours:** 75
THEORY	

COURSE OBJECTIVE:

To emphasize the concepts of evolution, divisions of genetics and fundamentals of genetic disorders

COURSE OUTCOMES:

1. Demonstrate the classical Mendelian experiments.
2. Interpret the impact non-Mendelian concepts.
3. Explain the principles of molecular basis of inheritance.
4. Discuss the theories and mechanism of evolution on genetic basis.
5. Discuss the effects of mutation in genetic disorders and gender defects.

UNIT 1: Classical Genetics: Mendelian Principles (15 hrs)

Historical concepts of genetics – Gregor Mendel's experiments on pea plants (Monohybrid cross and dihybrid cross) – Mendelian laws of inheritance: Law of dominance, law of segregation and law of independent assortment – Back cross – Test cross – Rediscovery of Mendelian Principles.

UNIT II: Classical Genetics: Extensions of Mendelian Principles (15 hrs)

Extensions of Mendelian principles: Morgan's experiments on Drosophila – Genetic linkage and crossing over, Alfred Sturtevant's linkage mapping, Codominance, incomplete dominance, multiple alleles, linkage and crossing over, gene interactions, pleiotropy, polygenic inheritance, genomic imprinting, epistasis, complementation, penetrance and expressivity.

UNIT III: Molecular Genetics (15 hrs)

Discovery of chromosomes - Chromosome theory of inheritance – Structural organization of chromosomes in prokaryotes and eukaryotes – Structure & types of chromosomes. DNA as the genetic material (Griffith's, Avery's and Hershey – Chase Experiments), Mutation – Types, mechanism and causes. Gene mapping methods: Mapping with molecular markers (RFLP and SNP). Human Genetics – Pedigree Analysis, Karyotyping, Overview of Human Genome Project.

UNIT IV: Population Genetics (15 hrs.)

Mechanism and Examples: Gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration (beetle and grassland) and random genetic drift (Bottle neck effect and Founders effect), adaptive radiation and modifications (Darwin Finches); isolating mechanisms (Giraffa Camelopardalis); speciation (Kaibab and Abert squirrels), sexual selection and co-evolution.

UNIT V Genetic and Chromosomal disorders in Humans (15 hrs)

Mendelian Disorders – Sex linked disorders: X-linked dominant (Fragile X Syndrome), X-linked recessive (Hemophilia) and Y-linked disorders (Hypertrichosis): Chromosomal abnormalities: Autosomal disorders (Down Syndrome), Sex chromosomal disorders (monosomy – Turner's syndrome, trisomy – Klinefelter syndrome) – Gender defects and gender defective phenotypes. chromosomal translocations and human cancer (hematopoietic and lymphoid tumors).

PRESCRIBED BOOKS:

1. Daniel L Hartl . Essential Genetics: A genomic perspective. Jones and Bartlett Publishers, 5th Edition, 2011.
2. Gardner, Simmons and Snutad Principles of Genetics, John Wiley & Sons Ltd., 8 Ed., 2005.

REFERENCE BOOKS:

1. Dr. P.S.Verma and V.K.Agarwal, Genetics, S.Chand Publishers, 2010.
2. Daniel L.Hartl, Bruce J.Cochrane, Genetics, Analysis of Genes and genomes, Jones and Bartlett Publishers, 6 th Ed., 2005.
3. R.S.Shukla, R.S.Shukla, Cytogenetics, Evolution, Biostatistics, Plant breeding, S.Chand, 5th Ed., 2016.
4. Richard Dawkins, The Selfish Gene, Oxford University Press, 4 Ed., 2016.
5. Steve Olson, Mapping Human History: Genes, Race and our common origins, Mariner Books; First Ed, 2003.

E-LEARNING RESOURCES:

1. https://egyankosh.ac.in/bitstream/123456789/41574/1/Unit-2.pdf
2. file:///C:/Users/Biotech1/Downloads/An%20Introduction%20to%20Genetic%20Analysis%20[11th]%20(%20PDFDrive%20).pdf
3. https://www.youtube.com/watch?v=mBq1ULWJp_M
4. https://www.youtube.com/watch?v=0bfpOhbKEAk&t=8s
5. https://www.youtube.com/watch?v=1ZXkPk9Rr5M

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	2	**1**	1
II	3	**2**	1
III	3	**1**	2
IV	2	**2**	1
V	2	**1**	1
TOTAL	12	7	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	2	2	3
CO 2	3	3	2	2	3
CO 3	3	3	2	2	3
CO 4	3	3	2	2	3
CO 5	3	3	2	2	2
Ave.	3	3	2	2	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Demonstrate the classical Mendelian experiments.	PSO1,PSO2 PSO4, PSO5	K1, K2, K3, K4
CO2	Interpret the impact of non-Mendelian concepts.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Explain the principles of molecular basis of inheritance	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4
CO4	Discuss the theories and mechanism of evolution on a genetic basis.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5
CO5	Discuss the effects of mutation in genetic disorders and gender defects.	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

PROGRAMME: B.Sc., Biotechnology	**BATCH:** 2024-27
PART: III	**COURSE COMPONENT:** CORE-VII
COURSE NAME: Genetic Engineering	**COURSE CODE:**
SEMESTER: IV	**MARKS:**100
CREDITS: 5	**TOTAL HOURS:** 60
THEORY	

COURSE OBJECTIVE:

To demonstrate the processes of r-DNA technology and discuss the technical aspects of every steps.

COURSE OUTCOMES:

1. Clear understanding of the Natural genetic recombination processes
2. Explain the mechanism of enzymes involved in Recombinant technology
3. Incorporate the ability to select the appropriate types of vectors and expression systems for molecular cloning
4. Distinguish between the Transformants and Non-Transformants
5. Enhance the basic skills in molecular techniques

UNIT 1 - Natural genetic recombination processes (15 hrs)

Genetic recombination in bacteria (transformation, transduction and conjugation) - Transposable elements - Horizontal (viral) and vertical (sexual reproduction) Gene transfer in animals - Restriction modification system – Basics of rDNA technology & molecular cloning - Ethical concerns of gene cloning.

UNIT II - Molecular tools (Enzymes) (15 hrs)

Nucleases: Endo and Exonucleases - Restriction Enzymes (Type I, II, III & IV) - RNases (Ribonuclease-H, Ribonuclease-A) - Dam Methylase - Polymerases: DNA Pol I, Klenow Fragments, Taq Polymerases - Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases, Reverse Transcriptases, Topoisomerases - Proteases: Endo & exopeptidases - Ligases: T4 & E. coli DNA Ligase.

UNIT III - Biology of Cloning vectors (15 hrs)

Properties of vectors - Bacterial vectors: pBR322, pUC, BAC – Bacteriophage vectors: λ phage vector, M13 vector, charon vector, cosmids, - Animal viral vectors: Retro viral and Vaccinia vector - Plant vectors: Ti and Ri plasmid vectors (Bipartite vectors), TMV and CaMV, Yeast Vectors: YAC - Expression vectors.

UNIT IV - Gene expression systems (15 hrs)

Bacterial expression systems (E. coli and Bacillus) - Yeast expression systems (*Saccharomyces cerevisiae* and *Pichia pastoris*) - Mammalian expression systems (Chinese hamster ovary cells and mouse myeloma cells) - Methods of gene transfer into the expression system: Chemical, Physical & Viral mediated DNA transfer - Screening techniques: Direct screening, Lac Z screening: Positive and negative.

UNIT V - Molecular techniques – Principle, Instrumentation, Applications (15 hrs)

Polymerase Chain Reaction - Quantitative Real Time PCR - Gel Electrophoresis: AGE & SDS- PAGE - Blotting Techniques: Southern, Western & Northern, FISH; Construction of Genomic & cDNA Libraries - DNA Sequencing methods (Maxam-Gilbert and Sanger's method) – Protein Engineering: Site Directed Mutagenesis - CRISPR CAS technique (Overview) – RNA Interference: siRNA, miRNA (overview).

PRESCRIBED BOOKS:

1. Principles of gene manipulation by R.W. Old and S.B. Primrose, Blackwell Scientific Publications, 1985.
2. J. M. Walker and E.B. Gingold, Molecular Biology and Biotechnology, Panima Publishing Corporation; 3 rd Ed., 2001
3. P.K.Gupta Elements of Biotechnology

REFERENCE BOOKS:

1. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering" 2008.
2. Russ Hodge and Nadia Rosenthal, "Genetic Engineering: Manipulating the Mechanisms of Life" (Genetics & Evolution) 2009.
3. Subodh Saxena, Genetic Engineering, Black Prints India Inc., 2014.

E-LEARNING RESOURCES:

Useful URL: https://ibkp.dbtindia.gov.in/Content/Commitee

1. https://www.youtube.com/watch?v=3IsQ92KiBwM
2. https://www.youtube.com/watch?v=BK12dQq4sJw
3. https://www.youtube.com/watch?v=glt8iAqK8NQ
4. https://www.youtube.com/watch?v=JmveVAYKylk
5. Useful URL: https://ibkp.dbtindia.gov.in/Content/Commitee

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions (each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions (each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions (each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	3	1	1
III	2	2	1
IV	2	1	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	**3**	**2**	**2**	**2**	**3**
CO 2	**3**	**3**	**3**	**2**	**3**
CO 3	**3**	**3**	**3**	**3**	**3**
CO 4	**3**	**3**	**3**	**2**	**3**
CO 5	**3**	**3**	**3**	**2**	**3**
Ave.	**3**	**2.8**	**2.8**	**2.2**	**3**

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Clear understanding of the Natural genetic recombination processes	PSO1, PSO5	K1, K2, K3, K4, K5
CO2	Explain the mechanism of enzymes involved in Recombinant technology	PSO1, PSO2, PSO3, PSO5	K1, K2, K3, K4, K5, K6
CO3	Incorporate the ability to select the appropriate types of vectors and expression systems for molecular cloning	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	Distinguish between the Transformants and Non-Transformants	PSO1, PSO2, PSO3, PSO5	K1, K2, K3, K4, K5
CO5	Enhance the basic skills in molecular techniques	PSO1, PSO2, PSO3, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-VIII
Course Name: Genetic Engineering and Immunology and Immunotechnology	**Course Code:**
SEMESTER: IV	**Marks:**100
CREDITS: 3	**Total Hours:** 30
Practical	

(a.)CORE VIII – PRACTICAL – IV: GENETIC ENGINEERING

COURSE OBJECTIVE:

To apply the principles of molecular techniques to examine biological samples and to isolate, visualize and analyze the biomolecules.

COURSE OUTCOMES:

1. Extract the biomolecules: Protein, DNA and RNA by centrifugation methods
2. Separate and observe the biomolecules by electrophoretic techniques
3. Estimate the biomolecules using the UV-spectroscopy analyses
4. Maintain the stock bacterial cell used in genetic engineering experiments
5. Demonstrate the amplification of DNA by PCR

Experiments:

1. Isolation of genomic DNA from E. coli cell culture and purity check by using UV-spectroscopic analysis.
2. Isolation of plasmid DNA from E. coli cell culture
3. Isolation of DNA from animal tissues
4. Analysis of the DNA samples using Agarose gel electrophoresis.
5. Determination of molecular weight of the DNA sample by graphical method.
6. Electroelution of DNA bands from agarose gel.
7. SDS-PAGE of proteins.

Demonstration Experiments:

1. Polymerase Chain Reaction
2. Restriction digestion and ligation
3. Blue white colony screening

PRESCRIBED BOOKS:

1. S. Janarthanan and S. Vincent, Practical Biotechnology: Methods and Protocols by Orient Black Swan and Universities Press, 2007
2. Heather Miller, D.Scott Witherow, Molecular biology techniques: A classroom laboratory manual, Academic Press 3rd Ed., 2011

REFERENCE BOOKS:

1. T.Maniatis, E.F.Fritsch, J.Sambrook, Molecular cloning, a laboratory manual (Volume-1, volume-2 and volume-3), Cold Spring Harbour, 3 rd , Ed., 2001.

2. S. Janarthanan and S. Vincent, Practical Biotechnology: Methods and Protocols by Orient Black Swan and Universities Press, 2007

3. Stefan Surzycki, Basic techniques in molecular biology, Springer, 2000.

4. Heather Miller, D.Scott Witherow, Molecular biology techniques: A classroom laboratory manual, Academic Press 3rd Ed., 2011

5. Basic Laboratory Calculation for Biotechnology by Seidman, Pearson, 2008

E-LEARNING RESOURCES:

1. https://www.bing.com/videos/riverview/relatedvideo?&q=sds+page+&&mid=793DA0C783F6FEBD2D07793DA0C783F6FEBD2D07&&FORM=VRDGAR
2. lecture 27.pdf (nptel.ac.in)
3. https://www.bing.com/videos/riverview/relatedvideo?&q=dna+isolation+e+coli+pdf&&mid=C12BA1CA6A073D1E3E37C12BA1CA6A073D1E3E37&&FORM=VRDGAR

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-VIII
Course Name: Genetic Engineering and Immunology and Immunotechnology	**Course Code:**
Semester: IV	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(b.) CORE VI: PRACTICAL – III: IMMUNOLOGY AND IMMUNOTECHNOLOGY

COURSE OBJECTIVE:

To identify the immune cells, disease diagnosis based upon agglutination and precipitation

Experiments:

1. Determination of blood clotting time
2. Differential staining and identification of WBC (Leishmann and Wright staining).
3. Identification of phagocytic cells
4. Serum protein separation by Agarose gel electrophoresis
5. Identification of Anti-inflammatory effects of turmeric by using RBC as model.
6. Agglutination reaction: Blood grouping, WIDAL, VDRL, ASO, CRP test
7. Precipitation reactions: SRID, ODD-pattern, Counter Immunoelectrophoresis

Demonstration experiments:

- Precipitation reactions: ODD-Antibody titer, Immunoelectrophoresis.
- ELISA-Qualitative detection of Antigens
- Western blotting

PRESCRIBED BOOKS:

1. Frank C. Hay, Olwyn Westwood, Practical Immunology (4th Ed.,), Blackwell Publications.

REFERENCE BOOKS:

1. Christine Dorresteyn Stevens, Clinical Immunology & Serology by A laboratoryperspective, 3rd Ed., F. A. Davis.

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Allied-IV
Course Name: Immunology and Immunotechnology	**Course Code:**
Semester: IV	**Marks:**100
Credits: 5	**Total Hours:** 75
Theory	

COURSE OBJECTIVE:

To familiarize the immune system, its functions and applications as therapeutic and diagnosis agents.

COURSE OUTCOMES:

1. Recall the evolution of immunology among various host cells.
2. Compile immune responses in various host cells.
3. Analyse the acquired responses
4. Differentiate the various, the processes involved in clearance of immuno-complex and hypersensitivity reactions.
5. Select the various immnotechnologies in disease diagnosis.

Unit- I: History of Immunology (15 hrs)

History of Immunology, Immune system: Lymphatic system (Primary and secondary lymphatic organs); Immune cells: Eosinophil, Basophil, Neutrophil, Monocytes, Macrophages, Lymphocytes (1. T-cells & their types, 2. B-cells & their types and activated B-cells) and Introduction of Immune responses: Innate immune response and Acquired immune responses.

Unit- II: Host Immune Responses and Antigens (15 hrs)

Types of antigens, haptens, properties of antigens; MHC molecules (types, structure); processing of antigens (Endocytic and Exocytic pathways); Identification , Structure, types, biological functions of Antibodies.

Unit- III: Acquired immune responses (15 hrs)

Acquired Immune response - Humoral immune response mechanism and Cell mediate immune responses: Cytotoxic cell responses, natural killer cells and Macrophage activation; Immune complex formation mechanism and types - (i.) Agglutination: Direct agglutination, indirect agglutination and Passive agglutination reactions (ii.) Precipitation reaction: three types- Single diffusion in single dimensions, double diffusion in single dimension, double diffusion in double dimension; Immune complex formation and its removal from host body: Complement pathway (Classical, Alternative, Mannose binding -lectin pathways), opsonization, Phagocytosis.

Unit- IV: Immunological disorders (15 hrs)

Immunological diseases: Severe combined immunodeficiency (SCID), HIV, M. tuberculosis; Hypersensitivity types and biological significance of: Type I- Anaphylatic reactions- Allergic reactions; Type II- Autoimune disorders: Type I diabetes – Goodpasture's syndrome – Multiple sclerosis – Grave's disease – Hashimoto' thyroiditis – Myasthenia gravis, Molecular mimicry; Type III- Immuno complex mediated hypersensitivity: autoimmune acute glomerulonephritis, rheumatoid arthritis, systemic lupus erythematosus; Type IV- Delayed hypersensitivity- Granulomatous; Immunological tolerance.

Unit: V- Immunotechnology (15 hrs)

Monoclonal antibodies production (Classical and modern methods) and their applications; Vaccines: Classical vaccination schedule and Recombinant vaccines based upon biomolecules: Epitope vaccines,

synthetic peptide vaccines, Recombinant vaccines based upon infectious agents: Bacterial, viral and parasitic (malaria), Transplantation immunology: HLA Typing and MLR; Recombinant vaccines for Cancer, Disease diagnostic techniques: Western Blotting, ELISA, FACS and Protein Microarray.

PRESCRIBED BOOKS:

1. Sudha Gangal and Shubhangi Sontakke, Textbook of basic and clinical Immunology, 2013.
2. Abul. K. Abbas, Andrew Litchman and Shiv Pillai, Cellular and molecular immunology,Elsevier Saunders, 8th Ed., 2014.

REFERENCE BOOKS:

1. B. Annadurai, A textbook of Immunology and Immunotechnology, 2010.
2. Kuby Immunology by Owen, Punt and Stranford, W.H.Freeman and Company, 7th
3. Ed., 2009.
4. A handbook practical and clinical immunology (Volume-1 & Volume-2) G.P Talwar andS.K.Gupta, CBs Publishers & Distributors, 2nd Ed., 2006.
5. Janeway, Travers, Walport, Shlomchik, Garland, "Immunobiology" 6th Edition, 2007.

E-LEARNING RESOURCES:

1.https://www.youtube.com/watch?v=LB9FYAo7SJU

2 .https://www.youtube.com/watch?v=G4jobV6-bFA

3.https://www.youtube.com/watch?v=_FLjj_Z7SKA

4.https://www.youtube.com/watch?v=Q3XpZjtciBQ

5.https://www.youtube.com/watch?v=iZYLeIJwe4w

6.https://www.youtube.com/watch?v=jrAw50B3jK0

7.https://www.youtube.com/watch?v=YO244P1e9QM

8.https://www.youtube.com/watch?v=lkoDv6qgRjE

9 ..https://www.youtube.com/watch?v=quv1oJlbsTc

10.https://www.youtube.com/watch?v=3g246c6Bv58

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions (each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions (each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions (each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	3	1	1
III	2	2	1
IV	2	1	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	2	3	3	3
CO 2	3	3	1	2	2
CO 3	3	3	1	1	2
CO 4	3	3	2	2	2
CO 5	3	2	2	2	3
Ave.	3	2.6	1.8	2	2.4

PSO-CO-question paper mapping

CO No:	COURSE OUTCOME	PSOs ADDRESSED	COGNITIVE LEVEL (K1 to K6)
CO1	Recall the evolution of immunology among various host cells	PSO1, PSO2, PSO4	K1, K2, K3, K4, K5, K6
CO2	Compile immune responses in various host cells	PSO1, PSO2, PSO4	K1, K2, K3, K4, K5, K6
CO3	Analyse the acquired responses	PSO1, PSO2, PSO4, POS5	K1, K2, K3, K4, K5, K6
CO4	Differentiate the various, the processes involved in clearance of immuno-complexand hypersensitivity reactions	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	Select the various immnotechnologies in disease diagnosis	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

PROGRAMME: ALL UG	**BATCH:** 2024 – 27
PART: IV	**COURSE COMPONENT:** EVS
COURSE NAME: Environmental Studies	**COURSE CODE:**
SEMESTER: IV	**MARKS:**100
CREDITS: 2	**TOTAL HOURS:** 30
THEORY	

UNIT-1 **(2 hrs)**

The Multidisciplinary nature of environmental studies Definition; Scope and importance, Need for public awareness.

UNIT-2 **(4 hrs)**

Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems.

a) Forest resources: Use and Over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water dams benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. - Role of an individual in conservation of natural resources. - Equitable use of resources for sustainable lifestyles.

UNIT-3: Ecosystems **(3 hrs)**

Concept of an ecosystem. - Structure and function of an ecosystem. - Producers, consumers and decomposers. - Energy flow in the ecosystem.

- Ecological succession. - Food chains, food webs and ecological pyramids. - Introduction, types, characteristic features, structure and function of the following ecosystem: -

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT-4: Biodiversity and its Conservation **(5 hrs)**

- Introduction-Definition: genetic, species and ecosystem diversity.
- Biogeographical classification of India.
- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India.
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-5: Environmental Pollution **(3 hrs)**

Definition - Causes, effects and control measures of:

a. Air pollution

b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes. - Role of an individual in prevention of pollution. - Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

UNIT-6: Social Issues and the Environment (5 hrs)

- From Unsustainable to Sustainable development.
- Urban problems related to energy. - Water conservation, rain water harvesting, watershed management.
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation.
- Consumerism and waste products.
- Environment Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and Control of Pollution) Act.
- Wildlife Protection Act.
- Forest Conservation Act.
- Issues involved in enforcement of environmental legislation.
- Public awareness.

UNIT-7: Human Population and the Environment (4 hrs)

- Population growth, variation among nations.
- Population Explosion-Family welfare Programme.
- Environment and human health.
- Human Rights.
- Value Education.
- HIV/AIDS.
- Women and Child Welfare.
- Role of information Technology in Environment and human health.
- Case Studies. UNIT-8: Field Work (Practical).
- Visit to a local area to document environmental assets-river/forest/grassland/ hill/mountain.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

UNIT-8: Field Work (Practical) (4 hrs)

- Visit to a local area to document environmental assets-river/forest/grassland/ hill/mountain.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

Prescribed Book:

Cover.p65 (ugc.gov.in)

Introduction to Environmental Science: 2nd Edition (usg.edu)

E-Learning Resources:

Chapter2.p65 (ugc.gov.in)

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-IX
Course Name: Bioprocess Technology	**Course Code:**
Semester: V	**Marks:**100
Credits: 5	**Total Hours:** 75
Theory	

COURSE OBJECTIVE:

To apply the principles of fermentation and bioprocess technology in product production and familiarize the downstream process in a sustained manner

COURSE OUTCOME:

1. Discuss the traditional and modern fermentation techniques.
2. Distinguish the parts of fermenters and the types of fermenters.
3. Interpret the media formulation, bacterial growth and kinetics involved.
4. Recognize the specific down-stream processes.
5. Discuss the bio-products produced by bioprocess technologies.

Unit I: Introduction to Bioprocess and Fermentation (15 hrs)

Scope of bioprocess technology; Difference between Fermentations and bioprocess processes; Industrial Microbes isolation; Strain improvisation, cell bank maintenance and preservation techniques; Types of fermentation process: Based upon gaseous requirements, mode of fermentation: Surface and submerged fermentation, Mechanism: Batch, Continuous and fed-batch fermentation.

Unit II: Bacterial cell inoculum and Kinetics (15 hrs)

Fluid mechanism, Kinetics of microbial growth (simple and unstructured kinetic models); Substrate utilisation kinetics; Mass transfer kinetics (Fick's law and its application, no derivations) and product formation: Metabolic stoichiometry and energetics (Eg- Citric acid), Yield pertaining to substrate utilisation and product (both biomass and biomolecules) formation; Leudeking – Piret model, Cell immobilisation techniques and types.

Unit III: Fermenters and stages of fermentation (15 hrs)

Definition of fermenter, Basic parts of fermenter, Types of fermenters: stirred tank fermenter, airlift fermenter, fluidised bed bioreactor, packed bed fermenter and Photo bioreactor, membrane reactor; Control of a fermenter: Pressure controls, temperature, gas flow control; Stages of fermentation process: Upstream and downstream process, Upstream process: steps in upstream process- Media formulation, strain improvisation, pilot scaling and up-scaling to fermenter.

Unit IV: Downstream process (15 hrs)

Extra cellular products and intra cellular products; Stages of Downstream process: (1) Removal of solids: flotation, flocculation, precipitation, centrifugation; (ii.) Product isolation: Liquid- Liquid Separation, adsorption, ultra-filtration (iii.) Product purification: Chromatography, crystallization, distillation, (iv.) Concentration: Evaporation, precipitation (v) Formulation: drying, freeze drying-lyophilisation, crystallization, Validation processes: Product validation and Cost validation (overview), GLP, GMP associated with Indian standards. Overview of fermented milk products as per Indian standards.

Unit V: Bioprocess Products (15 hrs)

Primary metabolites and secondary metabolites, Industrial important products: cellulase, amylase, lipase, protease- leather industry; Beverages: Wine; Recalcitrant products; Overview of Indian Pharmacopia; Antibiotics: Penicillin, recombinant product- Human Insulin (Actrapid), Growth

hormones (Humatrope), Vaccines: Hepatitis B vaccine (Recombivax HB), Monoclonal antibody-Rituximab.

PRESCRIBED BOOKS:

1. Rajiv Dutta, Fundamentals of Biochemical engineering, Springer (India), 2008.
2. Michael L. Shuler and FikertKargi, Bioprocess Engineering Basic concepts, Pearson Education India; 2 Ed., 2015.

REFERENCE BOOKS:

1. James E.Bailey and David F. Ollis, Biochemical Engineering fundamentals, McGrawHill Education; 2 Ed., 2017.
2. Pauline M.Doran, Bioprocess Engineering principles, Elsevier, 2nd Ed., 2012.
3. Wulf Crueger and Anneliese Crueger, "Biotechnology – textbook of Industrial Microbiology", reprint 2005. Panima publishing corporation, New Delhi.
4. A.H.Patel, (2000), "Industrial microbiology", Macmillan Publishers India.
5. Peter F. Stanbury, Whitaker.A, Principles of Fermentation Technology, Elsevier, 2nd Ed., 1995.
6. JayantoAchrekar, Fermentation Biotechnology, Dominant Publishers & Distributors(P) Ltd., 2006.
7. Najafpour, Yesdee, Biochemical Engineering and Biotechnology, Elsevier Science,1st Ed., 2006.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=-Uua8sfoJ8
2. https://www.youtube.com/watch?v=5eKdZ0dVCCo
   https://www.youtube.com/watch?v=VKpthcW1llU
3. https://www.youtube.com/watch?v=I0-w3om3rdU
4. https://www.youtube.com/watch?v=qbXtN-AiThQ
   https://www.youtube.com/watch?v=N7vxq948l-U
5. https://www.youtube.com/watch?v=fQOzHC828aM
   https://www.youtube.com/watch?v=Aw2yjoZ_RtY
   https://www.youtube.com/watch?v=uN0NwdR_3sI
6. https://dbtindia.gov.in/regulations-guidelines/regulations/biosafety-programme
7. https://www.bis.gov.in/wp-content/uploads/2023/01/Final-handbook-coloured_F_compressed.pdf
8. https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/knowyourstandards/Indian_standards/isdetails/MTk1OA==
9. https://www.services.bis.gov.in/tmp/WCFAD13620082_15112022_2.pdf
10. https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%
11. 252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B243-2003%
12. 252FCXS_243e.pdf

*Industrial visit to fermentation industries.

GUIDELINES TO THE QUESTION PAPER SETTERS
QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions (each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions (each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions (each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	2
II	3	1	1
III	2	2	1
IV	2	1	1
V	2	1	1
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	2	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	2.8	3

PSO-CO-question paper mapping

CO No:	COURSE OUTCOME	PSOs ADDRESSED	COGNITIVE LEVEL (K1 to K6)
CO1	Discuss the traditional and modern fermentation techniques	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	Distinguish the parts of fermenters and the types of fermenters	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Interpret the media formulation, bacterial growth and kinetics involved	PSO1, PSO2, PSO3, PSO4	K1, K2, K3, K4, K5, K6
CO4	Recognize the specific down-stream processes	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	To discuss the bio-products produced by bioprocess technologies	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-X
Course Name: Molecular developmental biology	**Course Code:**
Semester: V	**Marks:**100
Credits: 5	**Total Hours:** 75
Theory	

COURSE OBJECTIVE:

To familiarise developmental of the organism at molecular level and to apply the concept of genes involved in molecular defects in organism

COURSE OUTCOMES:

1. Recall the various fertilization.
2. Demonstrate the various developmental processes
3. Justification of the specific signaling mechanism involved in embryonic developmental
4. Demonstrate the genes involved in development of embryo
5. Diagnose the medical disorders related to developmental biology.

Unit I: Introduction to Developmental Biology (15 hrs)

Gametogenesis-process, Types of sperms and eggs (Frog, Chick and human); different types of Fertilization, Mechanism involved in fertilization in humans; Patterns of Cleavage, Blastulation & Gastrulation pertaining to frog, chick & humans, Characteristics of Plant developmental overview.

Unit II: Molecular developmental processes (15 hrs)

Growth, Differentiation (Stem cell to functional active cells), Development: re-differentiation, dedifferentiation, trans- differentiation, metamorphosis and morphogenesis and role of genes involved. Molecular development of plant- shoot and root formation in *Arabidopsis thaliana*.

Unit III: Signalling mechanism involved in development (15 hrs)

Signal transduction that control the organogenesis in Drosophila (GPCR pathway: Wnt, hedgehog pathway and Notch Delta pathway; Tyrosine kinase pathway: MAP-kinase, JAK- STAT, Serine threonine pathway: TGF-β pathway); Neurulation in Drosophila, Histidine kinase pathway in plant development.

Unit IV: Embryonic Development (15 hrs)

Genes that control the embryonic to fetus development: maternal genes, zygotic genes and homeotic genes using Drosophila as study model animal; Pattern formation in Drosophila- axis specification, fatemap; Comparative study of Regional specification among Drosophila and humans; Drosophila organ development: Nervous system and muscle.

Unit- V: Medical implications of developmental biology (15 hrs)

Gene therapy: Down's syndrome, fragile-X syndrome, congenital disorders- Neurological disorders (Anencephaly and cyclopia), thalassemia, Deformity disorders (improper digit separation in hand, cleft lip), Teratogenesis- microbial induced disorders- Rubella virusas example, Genetic counselling in India.

PRESCRIBED BOOKS:

1. Lewis Wolpert, Cheryll Tickle, and Alfonso Martinez Arias, Principles of developmental biology, Oxford University Press, 5th Ed., 2015.
2. T.Subramoniam, Molecular Developmental biology, 2nd Ed., Alpha Science, 2011.

REFERENCE BOOKS:

1. Scott F. Gilbert and Michael J.F.Barresi, Developmental Biology, Oxford University Press, 11th Ed., 2016.
2. Balinsky, An introduction to embryology, Cengage Learning India; 5 Ed., 2012.
3. Ramdass, Animal biotechnology recent concepts and developent, MJP, 2008.

E-LEARNING RESOURCES:

1. https://www.jove.com/science-education/5328/an-introduction-to-molecular- developmental-biology.
2. https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-bt36/#:~:text=This%20course%20will%20provide%20an,used%20to%20study%20plant%20development.
3. https://www.youtube.com/watch?v=DsK9R-yfgF4
4. https://www.youtube.com/watch?v=YtvL-LQlPrU
5. https://www.youtube.com/watch?v=YtvL-LQlPrU
6. https://www.youtube.com/watch?v=YtvL-LQlPrU
7. https://www.youtube.com/watch?v=J2DlGtOA3sA
   https://www.youtube.com/watch?v=J2DlGtOA3sA
   https://www.youtube.com/watch?v=RDt5ev9Q0Uk

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions (each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions (each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions (each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	3	1	1
III	2	2	1
IV	2	1	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	1	3	3
CO 2	3	3	1	2	2
CO 3	3	3	1	2	2
CO 4	3	3	1	1	2
CO 5	3	3	1	3	3
Ave.	3	3	1	2.2	2.4

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Recall the various fertilization	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	Demonstrate the various developmental processes	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Justification of the specific signaling mechanism involved in embryonic developmental	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	Demonstrate the genes involved in development of embryo	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	Diagnose the medical disorders related to developmental biology	PSO1, PSO2, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-XI
Course Name: Bioinformatics and Biostatistics	**Course Code:**
Semester: V	**Marks:**100
Credits: 5	**Total Hours:** 75
THEORY	

COURSE OBJECTIVE:

To make the students to understand the importance of *in silico* studies and Biostatistical analysis in biological research

COURSE OUTCOMES:

1. Recall the importance of bioinformatics and its scope
2. Distinguish the different types of biological databases and their importance
3. Understand the various steps involved in the drug discovery pipeline
4. Discuss the importance of biostatistics and its scope
5. Learn to calculate the measures of central tendency and dispersion

UNIT 1 **(15 hrs)**

Importance and scope of Bioinformatics. Introduction to Human genome project. Biological databases (types based on data type and data source, applications) – Data Bank (GenBank, PDB), Pubchem, Pairwise sequence alignment and multiple sequence alignment - analysis of nucleic acid and protein sequence data using web-based tools.

UNIT II **(15 hrs)**

Gene prediction approaches – prokaryotes and eukaryotes - Open Reading Frame (ORF) prediction – Hidden Markov Model - In-silico Drug designing: characteristics of a drug compound, drug discovery pipeline: target identification, lead compound identification, serendipity, QSAR, ADME predictions.

UNIT III **(15 hrs)**

Types of tertiary structures - (α-α: Collagen, β-α (Rosmann fold), β-β (Jelly roll -Beta barrels-transporter proteins) quaternary structures: hemoglobin structure. Protein secondary structure prediction: First Generation – Chou-Fasman, Garnier- Osguthorpe- Robson (GOR) methods - Homology modelling, phylogenetic analysis.

UNIT IV **(15 hrs)**

Introduction, Scope and applications of Biostatistics - Common terms (Population, Sample, Parameter, Data, Constant and variables) - Sampling techniques - Biological data - Collection of data, Processing of data, Presentation of data: Numerical presentation and Graphical representations (Line graph, Frequency polygon and curve, Histogram, Bar chart, Pie chart) - Central tendency- Arithmetic mean, Median and Mode (problems).

UNIT V **(15 hrs)**

Range, Variance, Standard Deviation (problems) - Coefficient of Variation and Probability - Theoretical distributions: Binomial and Poisson distribution, Normal distribution: Skewness and kurtosis - Significance: Hypothesis testing (Type of errors), Student's t-test, Chi square test (no problems).

PRESCRIBED BOOKS:

1. Jin Xiong "Essential Bioinformatics", 1st edition Cambridge University Press, 2006.
2. Arthur Lesk "Introduction to Genomics" 2nd edition. Oxford University Press 2007.

REFERENCE BOOKS:

1. Andreas D Baxevanis, B F Francis Oullette "Bioinformatics: A practical guide to the analysis of genes and proteins". 2nd edition. Wiley publishers, 2005.
2. Jin Xiong "Essential Bioinformatics", 1st edition Cambridge University Press, 2006.
3. David Mount "Bioinformatics: sequence and genome analysis" 3rd edition. Cold Spring Harbor Laboratory Press, 2004.
4. Biotechnology & Bioinformatics by Ranganathan, Narain & Kuppuswamy, Wisdom Press, 2011.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=w-uk-_TOgR0&list=PLb0WW0k29aHrF8a ZzK17ORTesZsd lING
2. https://www.youtube.com/watch?v=ZNIQCrCIbL8
3. https://www.youtube.com/watch?v=IQCbnRafCtM
4. https://www.youtube.com/watch?v=cd6O8FbrVjw
5. https://www.youtube.com/watch?v=SAweFv8I8ow&list=PL1ay9ko4A8skYqjhrA4IND Z7IHtebS0l Y

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	2	1	1
II	2	2	1
III	3	1	1
IV	3	2	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	1	1	3
CO 2	3	3	3	3	3
CO 3	3	3	2	2	3
CO 4	3	3	1	1	3
CO 5	2	3	1	1	3
Ave.	2.8	3	1.6	1.6	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Recall the importance of bioinformatics and its scope	PSO1, PSO2, PSO5	K1, K2, K3, K4, K5
CO2	Understand the various steps involved in the drug discovery pipeline	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Acquire in depth knowledge about the protein structure prediction.	PSO1, PSO2, PSO5	K1, K2, K3, K4, K5
CO4	Discuss the importance of biostatistics and its scope	PSO1, PSO2, PSO5	K1, K2, K3, K4, K5
CO5	Learn to calculate the measures of central tendency and dispersion	PSO2, PSO5	K1, K2, K3, K4, K5

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-XII
Course Name: Bioprocess Technology, Molecular Developmental Biology, Bioinformatics And Biostatistics	**Course Code:**
Semester: V	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(a.) CORE XIII – PRACTICAL – V: BIOPROCESS TECHNOLOGY

COURSE OBJECTIVE:

To apply the theory of fermenter and fermentation in upstream and downstream process

COURSE OUTCOMES:

1. Compare the different types of fermentation processes.
2. Discuss about the importance of cell immobilization techniques in fermentationprocesses.
3. Examine and describe the applications of parts of SS-grade fermenter.
4. Prepare wine and relate the importance of submerged fermentation processes.
5. Prepare citric and to discuss the application of surface fermentation processes.

Experiments:

1. Cell immobilization by alginate gel method
2. Hydrolysis of starch by free and immobilized yeast
3. Microbial growth curve estimation by using Yeast cells
4. Detection of Lipase production microbes
5. Wine production by *Saccharomyces cerevisiae*: Must preparation, detection of total acid concentration by titration method, sugar analysis by brix method, demonstration of pigment by TLC and UV-Spectroscopy method and ageing.
6. Citric acid production by *Aspergillus niger*; Media formulation (Rice powder, standard starch), estimation of total acid, product recovery (Downstream process-demonstration).
7. Effect of various temperature in bread baking and analysis of the texture, colour.
8. Demonstration of biomass production by Spirulina culture

Demonstration Experiments:

1. To demonstrate the parts of the industrial grade SS-fermenter.
2. Amylase production by *Bacillus subtilis* using a fermenter (Laboratory scale to Pilotscale) and detection of amylase and identify the concentration of product produced.
3. Demonstration of compost production- as example for solid state fermentation process.

REFERENCE BOOKS:

1. Brain Mcneil and Linda M.Harvey Strathclyde Fermentation centre, Strathclyde University, Practical Fermentation technology. John Wiley and Son. (2008). ISBN 978-0-470-01434-9, L-G-0000578561-0015278598.pdf (e-bookshelf.de)

E-LEARNING RESOURCES:

1. Applied Biosciences | Free Full-Text | Citric Acid Production by *Aspergillus niger* Using Solid-State Fermentation of Agricultural Processing Coproducts (mdpi.com)
2. Full article: Overview of citric acid production from *Aspergillus niger* (tandfonline.com)
3. Isolation, optimization and molecular characterization of lipase producing bacteria from contaminated soil (sciencedirectassets.com).

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-XII
Course Name: Bioprocess Technology, Molecular Developmental Biology, Bioinformatics and Biostatistics	**Course Code:**
Semester: V	**Marks:**100
Credits: 3	**Total Hours:** 30
PRACTICAL	

(b.) CORE XIII – PRACTICAL – V: MOLECULAR DEVELOPMENTAL BIOLOGY AND BIOINFORMATICS AND BIOSTATISTICS

COURSE OBJECTIVE:

To learn about the molecular developmental process by using chick as model ad to recall the on-line biological data bases

COURSE OUTCOMES:

1. Gain knowledge about the different stages of development using Fenugreek or Moong Dal
2. Gain knowledge about embryonic development by using chick embryo and the different stages of development of the chick embryo
3. Observe the different stages of development of a frog embryo
4. Access and retrieve the sequences from the nucleotide and protein databases and to retrieve articles from the Literature databases.
5. Apply online tools to understand the protein structures and to compare two or more nucleotide or protein sequences.

Unit-1: Experiments:

1. To observe and record the different stages of plant development using seeds (Fenugreekor Moong dhal) as study model.
2. Observe the fertilized egg (to detect Growth and position of chick embryo; Day1 to Day-7) by using "Egg Candler" and isolation of chick embryo.
3. Flybase tools- Importance to molecular developmental biology

Unit-1: Experiments: Bioinformatics

1. Study of Internet resources in Bioinformatics.
2. Searches on MEDLINE, PubMed databases.
3. Introduction to sequence databases: Protein sequence databank – UNIPROT, Nucleic acid sequence databank – Gene bank, EMBL, DDBJ.
4. Sequence alignment - BLAST, FASTA
5. Multiple alignment – Clustal Omega.

Demonstration Experiments:

1. Using chick embryo as a model to study the following by the wet mount preparation andrecord the observation (Number of somites and to monitor the organs development at different time intervals):
   - A.Observation and description of 24 hrs. chick embryo
   - B. Observation and description of 48 hrs. chick embryo
   - C.Observation and description of 72 hrs. chick embryo
   - D.Observation and description of 96 hrs. chick embryo
2. Record the life cycle of frog.
3. Observation of frog embryo (Blastula, Late gastrula stages)
4. To understand Wound healing mechanism using tadpole as specimen.

5. Hormonal induced developmental metamorphosis using tadpole as sample

Demonstration Experiments (Biostatistics)

1. Analysis of biological data by calculating Mean, Median, Mode and standard deviation
2. Data presentation using Bar diagram, Histogram, Pie chart

PRESCRIBED BOOKS:

1. P.S.Verma and V.K.Agarwal, Chordate Embryology, S.Chand, 2006.
2. Laura R.Keller, Experimental Developmental Biology-a laboratory manual, Academic Press, 1st Ed., 1999.

REFERENCE BOOKS:

1. James Sharpe and Rachel O.Wong, Imaging in developmental Biology: A laboratory manual, Cold Spring Harbor Laboratory Press, Ist Ed., 2011.

E-LEARNING RESOURCES:

1. https://www.bing.com/videos/riverview/relatedvideo?&q=chick+embryo+developmental+stages&&mid=CFB02E50E01B8B26D6D1CFB02E50E01B8B26D6D1&&FORM=VRDGAR
2. https://www.bing.com/videos/riverview/relatedvideo?&q=chick+embryo+developmental+stages&&mid=09A960BAC32532C0CC2209A960BAC32532C0CC22&&FORM=VRDGAR
3. https://www.bing.com/videos/riverview/relatedvideo?&q=frog+development&&mid=AC2CF51A2F5CFEF110B2AC2CF51A2F5CFEF110B2&&FORM=VRDGAR
4. https://www.bing.com/videos/riverview/relatedvideo?&q=frog+development&&mid=C2B672C27B1E693EEAF2C2B672C27B1E693EEAF2&&FORM=VRDGAR

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Elective (Interdisciplinary Elective)-I
Course Name: Intellectual Property Rights	**Course Code:**
Semester: V	**Marks:**100
Credits: 3	**Total Hours:** 30
THEORY	

COURSE OBJECTIVE:

To understand the history of Intellectual property rights, origin of IPR, global and Indian IPR.

COURSE OUTCOMES:

1. Recall the fundamentals of IPR
2. Familiarize the legality related to patent law
3. Demonstrate the legality related to copy right and trademarks
4. To recall the legality associated with design, geographical indicators of both at Global and National levels.
5. Familiarize the recent amendments in the IPR laws.

Unit-I: Introduction of IPR (15 hrs)

Introduction and the need for intellectual property right (IPR) Types of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secrets IPR in India : Genesis and development IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit-II: Patents (15 hrs)

Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps) Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents Patent Infringement, Remedies & Penalties – Patent Office and Appellate Board. Patent/Prior art search: Types and tools of patent search, Patent drafting: Elements in patent drafting.

Unit-III: Copyrights (15 hrs)

Copyrights - Nature of Copyright - Subject matter of copyright: original literary, dra matic, musical, artistic works; cinematograph films and sound recordings Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright Copy right Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

Unit-IV: Trademarks and Designs (15 hrs)

Trademarks - Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well-known marks, certification marks and service marks) - Non-Registrable Trademarks Registration of Trademarks - Rights of holder and assignment and licensing of marks Trademark Infringement, Remedies & Penalties - Trademarks registry and appellate board.

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection Plant Variety Protection Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection Layout Design Protection Layout Design protection: meaning – Procedure for registration, effect of registration and term of protection.

Unit-V Current scenario in India **(15 hrs.)**

Introduction to the Indian Patent act-1970, India`s New National IP Policy, 2016 – Govt. of India step towards Promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies (Neem, Super bug, basmati rice).

PRESCRIBED BOOKS:

1. FINAL_IPR&LP_BOOK_10022020.pdf (icsi.edu)
2. Deepa Goal and Shomini Parasar. IPR, Biosafety and Bioethics. Pearson. (2013). ISBN 9788131774700, eISBN 9789332514249.

REFERENCE BOOKS:

1. W. Cornish & Llewelyn – Intellectual Property: Patent, Copyrights, Trade Marks & Allied Rights", London Sweet & Maxwell.
2. J. P. Mishra – An Introduction to Intellectual Property Rights
3. B.L. Wadehra - Law Relating to Intellectual Property 5th Edition
4. P. Narayanan – Intellectual Property Law

E-LEARNING RESOURCES:

1. Study on (icai.org)

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	2	1	1
II	2	2	1
III	3	1	1
IV	3	2	1
V	2	1	2
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No.	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Recall the fundamentals of IPR	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K6
CO2	Familiarize the legality related to patent law	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K6
CO3	Demonstrate the legality related to copy right and trademarks	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K6
CO4	To recall the legality associated with design, geographical indicators of both at Global and National levels	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K6
CO5	Familiarize the recent amendments in the IPR laws	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

PROGRAMME: ALL UG	**BATCH:** 2024 – 27
PART: IV	**COURSE COMPONENT:** Value Education
COURSE NAME: Value Education	**COURSE CODE:**
SEMESTER: V	**MARKS:**100
CREDITS: 2	**TOTAL HOURS:** 30
THEORY	

UNIT 1: EDUCATION AND VALUES (6 hrs)

Definition, Concept, Classification, Theory, Criteria and Sources of values Aims and objectives of value education Role and Need for value education in the contemporary society, Role of education in transformation of values in society Role of parents, teachers, society, peer group and mass media in fostering values

UNIT 2: VALUE EDUCATION AND PERSONAL DEVELOPMENT (6 hrs)

Human Values: Truthfulness, Sacrifice, Sincerity, Self-Control, Altruism, Scientific Vision, relevancy of human values to good life. Character Formation towards Positive Personality Modern challenges of adolescents: emotions and behaviour Self-analysis and introspection: sensitization towards gender equality, differently abled, Respect for - age, experience, maturity, family members, neighbours, strangers, etc.

UNIT 3: HUMAN RIGHTS AND MARGINALIZED PEOPLE (6 hrs)

- Concept of Human Rights – Principles of human rights – human rights and Indian constitution – Rights of Women and children – violence against women – Rights of marginalized People – like women, children, minorities, transgender, differently abled etc.

- Social Issues and Communal Harmony Social issues – causes and magnitude - alcoholism, drug addiction, poverty, unemployment – communal harmony –concept –religion and its place in public domain –secular civil society

UNIT 4: VALUE EDUCATION TOWARDS NATIONAL AND GLOBAL DEVELOPMENT (6 hrs)

- Constitutional Values :(Sovereign, Democracy, Socialism, Secularism, Equality, Justice, Liberty, Freedom, Fraternity)
- Social Values: (Pity and Probity, Self-Control, Universal Brotherhood).
- Professional Values :(Knowledge Thirst, Sincerity in Profession, Regularity, Punctuality, Faith).
- Religious and Moral Values: (Tolerance, Wisdom, character).
- Aesthetic Values: (Love and Appreciation of literature, fine arts)
- Environmental Ethical Values
- National Integration and international understanding.
- Need of Humanistic value for espousing peace in society. Conflict of cross-cultural influences, cross-border education

UNIT 5: (6 hrs)

- Guru Nanak Devji's Teachings
- Relevance of Guru Nanak Devji's teachings' relevance to Modern Society
- The Guru Granth Sahib
- The five Ks

- Values and beliefs
- Rights and freedom (Right of equality, Right to Education, Right to Justice, Rights of women, Freedom of religion, Freedom of culture, Freedom of assembly, Freedom of speech)
- Empowerment of women
- Concept of Langar
- Eminent Sikh personalities

REFERENCE BOOKS:

1. Dr. Abdul Kalam. My Journey-Transforming Dreams into Actions. Rupa Publications, 2013.
2. Steven R Covey, 8th Habit of Effective People (From Effectiveness to Greatness), Free Press, New York, 2005.
3. Prem Singh, G.J. (2004). 'Towards Value Based Education', University News. Vol. 42 (45): P.11-12.
4. V.R. Krishna Iyer. Dialectics & Dynamics of Human Rights in India (Tagore Law Lectures) The Yesterday, Today and Tomorrow, Eastern Law House **(**1999, Reprint 2018)
5. http://www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf

Programme: B.Sc., Biotechnology	**Batch:** 2024-27
Part: III	**Course Component:** Core-XIII
Course Name: Plant and Animal Biotechnology	**Course Code:**
Semester: VI	**Marks:**100
Credits: 5	**Total Hours:** 75
THEORY	

COURSE OBJECTIVE:

To understand the fundamental aspects of plant and animal biotechnology

COURSE OUTCOMES:

1. Describe the fundamental aspects of plant biotechnology
2. Apply the concepts of genetic engineering in the generation of transgenic plants and their applications.
3. Demonstrate animal cell culture techniques
4. Realize the significance of transgenic, cloning and reproductive technology
5. Distinguish the properties of stem cells and can correlate it with tissue engineering

UNIT I: Overview of Plant Biotechnology and Tissue Culture (15 hrs)

Overview of Plant Biotechnology: History: global and Indian, Indian Scientist contributions, Scopes of Plant Biotechnology.

Tissue Culture: History of Plant Tissue Culture, Types of medium: MS medium, Gamborg, White's and Nitsch's medium; Types of Explants, Surface sterilization; Methods of tissue cultures, stages of callus, Micropropagation, hardening and transfer to the field.

UNIT II: Applications of Plant Biotechnology (15 hrs)

Transgenic plants: Insect resistant plants, pesticide resistant plants, plants with longer shelf lives- Pomato, , Case study: BT-cotton, Salinity resistant rice, Brinjal, Okra; Biofortified plant: Golden rice, tissue culture in ornamental plant, transgenic plants: fruits and flower with longer shelf life, Phycotechnology: Production and Application in Pharmaceutical Industry, Biofuels and Phytoremediation; Overview of Codex Alimentaruis for labeling for GMO food crops, Role and responsibilities of Food and agricultural organization of United Nations (FAO) focusing: Goal 1, 2, 3, Indian system of GMO crops labeling.

Unit III: History of breeding and Assisted reproductive techniques (15 hrs)

History of animal breeding, Human Reproductive health – Infertility in humans - Causes and risk factors of male and female infertility - Assisted reproductive technology: Methods, types and steps of AI, IVF, GIFT, ZIFT, ICSI, & Third-party assisted ARTs. Livestock improvement methods: Introduction, selection and breeding.

Unit-IV: Cell line techniques (15 hrs)

Cell lines and maintenance, Buffers and medium, types of cell lines, Methods for the production of transgenic animals, Applications of Transgenic animals, Cloning- Types; Pros and cons of animal cloning.

Unit V: Overview of Stem cell biology and tissue engineering (15 hrs)

Stem cells: Properties, mechanism of stem cell differentiate into functional active cells, and application; Tissue engineering: Cell to *invitro* histopathic culture; Bioartificial organs, Overview of Biomimetics and Example: Bat based blind man stick, Gecko foot based adhesive tapes.

PRESCRIBED BOOKS:

1. J. H. Dodds, Plant Genetic Engineering, Cambridge University Press, 1983.
2. Arie Altman Paul Hasegawa, Plant Biotechnology and Agriculture, Academic Press, 2012.
3. Slater, Plant Biotechnology, Oxford, 2nd Ed., 2008.
4. P. Madhusudan Rao, Plant Tissue Culture & Biotechnology, Black Prints/ Dominant Publishers & Distributors Pvt Ltd India, 2013.
5. R. Ian Freshney, Culture of Animal Cell: A Manual of Basic Technique and specialized applications, 6th Ed., Wiley Blackwell, 2011.
6. Heiner Niemann, Christine Wrenzycki, Animal Biotechnology 1: Reproductive Biotechnologies, Springer, 2018.

REFERENCE BOOKS:

1. Dr. Ahindra Nag Textbook of Agricultural Biotechnology, PHI Learning Private Ltd., New Delhi, 2009.
2. Plants Genes and Agriculture by Chrispeels, Jones and Bar, 2nd Ed., 2013.
3. Fruit and Vegetable Biotechnology (2 Vols.) by Raghuraj Chintamani, Dominant Publishers & Distributors (P) Ltd., 2008.
4. Butler, Animal Cell Culture & Technology, Taylor & Francis Publications, 2nd Ed., 2003.
5. David S. Goodsell, "Bionanotechnology", John Wiley&Sonsinc., publications, 2004.
6. Oguzhan Gunduz et al., Biomaterials and Tissue Engineering, 1st edition, Springer, 2023.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=6y13hYGPi8Q
2. https://www.youtube.com/watch?v=TORRxwbz7aY
3. https://www.youtube.com/watch?v=ykKs5icYwq0
4. https://www.youtube.com/watch?v=RzYhcXjksKc
5. https://www.youtube.com/watch?v=qybFQJ4-KEY
6. https://www.youtube.com/watch?v=766QH_qaYN8

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	2	2	2
II	3	1	1
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PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No:	COURSE OUTCOME	PSOs ADDRESSED	COGNITIVE LEVEL (K1 to K6)
CO1	Describe the fundamental aspects of plant biotechnology	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	Apply the concepts of genetic engineering in the generation of transgenic plants and their applications.	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Demonstrate animal cell culture techniques	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	Realize the significance of transgenic, cloning and reproductive technology	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	Distinguish the properties of stem cells and can correlate it with tissue engineering	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch**: 2024-27
PART : III	**Course Component**: Core-XIV
Course Name: Biosafety, Bioethics and IPR	**Course Code**:
Semester: VI	**Marks**:100
Credits: 5	**Total Hours**: 75
Theory	

COURSE OBJECTIVE:

To know about the biosafety guideline at lab, research and industrial setups, to apprehend the bioethics and apply IPR.

COURSE OUTCOMES:

1. Apply the various level of Biosafety at lab, research and industrial setups.
2. Familiarize bioethics in the field of Biotechnology.
3. Demonstrate research ethics.
4. Familiarize with IPR related to the field of Biotechnology.
5. Apply IPR in Biotechnology related areas.

Unit I: Biosafety and committees (15 hrs)

Regulatory bodies and their functions: Overview of Department of Biotechnology (DBT), Biotechnology Regulatory Authority of India: National Biotechnology Regulatory Authority (NBRA) and National Biotechnology Development Strategy (NBDS), Indian Regulatory bodies (RADC, RCGM, GEAC) and their: roles, Biosafety regulations of Genetic engineering in India and at global level.

Biosafety: Introduction, history, objectives of Biosafety. Risk assessment in biotechnological research and their regulation of GMO's. Field trail and planned introduction of GMO's. Biosafety guidelines in India. Biosafety levels of Plants, animals: Acute oral safety limit study in rats and mice and microbial research.

Unit II: Bioethics (15 hrs)

Introduction, Ethical issues related to biotechnology. Legal and socio-economic impacts of biotechnology. Ethical concerns of gene cloning and stem cell research. World war-ii, Bhopal gas and Chernobyl tragedies pharmaceutical al disaster- HINI outbreak, Bioethics in animal experimentation, Bioterrorism.

Unit III: Research Ethics (15 hrs)

Research ethics – Introduction, code of conduct of research, Validation of research, Confidentiality in research (Collection, Recording, Usage in research and safe guarding the biological, personal information). Plagiarism – Importance and effects of Plagiarism and its identification software (Urkund and Turnitin), Scientific misconduct: salami, gift of authourship, Biopiracy.

Unit IV: IPR: History, Overview (15 hrs)

Genesis of IPR: Paris Convention (1883), Berne Convention (1886), The Universal Copy Right Convention (1967), WIPO Convention (1967), Patent Co-operation Treaty (1970), TRIPS Agreement (1994); Registration, granting procedure, Infringement, remedies and penalties: Patent and types, Copyright, Trade mark, Design, GI, Difference between GI and trademarks, Plant Breeder's Rights, Protection of Plant Varieties and Farmers Rights, Trade secrets.

Unit V: (15 hrs)

Genetic Resources and Traditional knowledge; Introduction to the Indian Patent act-1970; India`s New National IP Policy, 2016 – application for IPR; Govt. of India step towards Promoting IPR –

Govt. funding Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies (Neem, Super bug, basmati rice).

REFERENCE BOOKS:

1. Shaleesha A, Stanley, Bioethics, Wisdom educational service, 2008.
2. Das H.K., Text book of Biotechnology, Wiley Publishers, 2010.

E- LEARNING RESOURCES:

1. Guidelines_and_SOPs_for_confined_field_trials_of_regulated_GE_Plants,2008.pdf (dbtindia.gov.in)
2. Microsoft Word - Coverpage.doc (dbtindia.gov.in)
3. Corporate Excellence _ Sanjay (dbtindia.gov.in)
4. https://www.youtube.com/watch?v=Ew2OmY_Uer4
5. https://www.youtube.com/watch?v=9wgFZuBXKfc
6. https://www.youtube.com/watch?v=CAM6VNDYJ6k
7. https://www.youtube.com/watch?v=KQwVXqoTfVg
8. Biotech regulation in India: Problems and promises - Reddy - 2009 - Biotechnology Journal - Wiley Online Library

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	2	2	2
II	3	1	1
III	2	1	1
IV	2	2	1
V	3	1	1
TOTAL	12	**7**	6
SECTION A - 12		**SECTION B – 7**	**SECTION C – 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Apply the various level of Biosafety at lab, research and industrial setups	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	Familiarize bioethics in the field of Biotechnology	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Demonstrate research ethics	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	Familiarize with IPR related to the field of Biotechnology	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	Apply IPR in Biotechnology related areas	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch**: 2024-27
PART: III	**Course Component**: Core-XV
Course Name: Plant and Animal Biotechnology	**Course Code**:
Semester: VI	**Marks**:100
Credits: 3	**Total Hours**: 30
Practical	

(a.)CORE XVII - PRACTICAL VI: PLANT BIOTECHNOLOGY

COURSE OBJECTIVE:

To familiarise the techniques involved in plant tissue culture

COURSE OUTCOMES:

1. Recall basics of plant tissue culture
2. Familiarize the sterilization of explants.
3. Demonstrate Micropropagation
4. Familiarize protoplast isolation and fusion technique
5. Demonstrate isolate the Plant DNA.

Experiments:

1. Specific surface sterilization methods for different types of explants (leaf, nodal tissues,stem, seed, root and embryo).
2. Callus propagation using chickpea/fenugreek and observe the various stages of callus.
3. Callus squash preparation and staining of callus cells using acetocarmine stain
4. Micropropagation of carrot explants
5. Isolation of protoplast (mechanical and enzymatic method) and its viability check by Evans' blue dye and protoplast fusion demonstration.
6. Plant DNA isolation by CTAB method and visualization by Agarose electrophoresis.

Demonstration Experiments:

1. Preparation of MS medium and the hormone stock preparation.
2. Detection of IAA production by rhizosphere bacteria (*Aztobacter* spp.) by Salkowski method on TLC.
3. Demonstration of Oyster mushroom cultivation (Mycelium growth, spawn preparation, sporangia formation).

REFERENCE BOOKS:

1. H. S. Chawal, Plant Biotechnology: A Practical Approach, Science Publishers, U.S., 2003.
2. https://indiabioscience.org/media/articles/DBT-Life-Science-Protocol-Manual.pdf

Programme: B.Sc., Biotechnology	**Batch**: 2024-27
PART: III	**Course Component**: Core-XV
Course Name: Plant and Animal Biotechnology	**Course Code**:
Semester: VI	**Marks**:100
Credits: 3	**Total Hours**: 30
Practical	

(b) Animal Biotechnology

COURSE OBJECTIVE:

To familiarise with the animal cell line culture

COURSE OUTCOMES:

1. Familiarize the basic set up of the animal cell culture lab
2. Recall the preparation of single cell suspension from the animal tissues.
3. Demonstrate the cell viability techniques
4. Familiarize the medium preparation techniques.
5. Familiarize adherent cell line establishment

Experiments:

1. Preparation of animal cell culture buffers and pH standardization.
2. Preparation of animal cell culture medium and membrane sterilization.
3. Isolation of cells from animal tissues by mechanical methods
4. Morphological observation of the isolated cells using various stains (Methylene blue, Leishman stain, Trypan blue).
5. Determining the percentage of cell viability using dye exclusion method
6. Preparation of single cell suspension for monolayer culture by enzymatic method.

Demonstration Experiments:

1. Over view of the setup of animal cell culture laboratory
2. Monitory and maintenance of animal cell cultures

REFERENCE BOOKS:

1. Sudha Gangal, Principles and Practice of Animal Tissue Culture, UniversitiesPress, Universities Press (India) Limited, 2007.
2. https://indiabioscience.org/media/articles/DBT-Life-Science-Protocol-Manual.pdf

Programme: B.Sc., Biotechnology	**Batch**: 2024-27
PART : III	**Course Component**: Elective-II
Course Name: Environmental Biotechnology	**Course Code**:
Semester: VI	**Marks**:100
Credits: 5	**Total Hours**: 75
Theory	

COURSE OBJECTIVE:

To train the students in waste mitigation and orient them about the Global and Indian norms related to waste mitigation.

COURSE OUTCOMES:

1. Correlate the SDG's
2. Illustrate the methods contributing to the pollution.
3. Familiarize with various molecular techniques involved in wastage mitigation
4. Demonstrate the importance of pollution mitigation
5. Apply the pollution regulation of both State and National

Unit I: Scope of Environmental Biotechnology (15 hrs)

Definition of Environmental Biotechnology, Importance of Environmental suitability: Sustainable goals (Global and Indian), Circular economy: Principles and practices, Concept of zero waste, Indian environmental policies to support circular economy, Impact of circular economy on economic growth: global and national, Microbial role in Carbon Storage (sequestration, conversion to useful biopolymers- bioplastic & Biofuel), Bioindicators to monitor the health of environment: air, water and soil (PGPB), forest-Plants (Bamboo and lichens), glacier.

Unit II: Biotechnological approaches in climate change & agriculture management (15 hrs)

Air borne infection, use of microbes in removal of waste from air and soil, Integrated farming methods, Vertical agriculture: Methods and benefits, Hydrophonics: Methods and benefits, Rhizospheric and Endophytic microbes to provide a safe and affordable means of crop biofortification, Effect of climate change on microbes related micronutrient deficiency in plants (Microbial role in iron transport to plants).

Unit III: Biotechnological approach in water management (15 hrs)

Bioremediation: bioaugmentation and biostimulation, Grey water (house hold sewage water): treatment methods; Advanced portable water treatment: Water – Softening, Adsorption, Desalination, Reverse Osmosis, microbial based, Biosensors for water pollution indicator, Biotechnology approaches for industrial effluent treatment (Paper, tannery and dye). Tamil Nadu Water Quality Standards and Guidelines for industrial effluent discharge, role of Tamil Nadu water supply and drainage board (TWAD).

Unit IV: Biotechnological approach to waste management (15 hr)

Role of microbes in degradation of Aliphatic and Aromatic compounds by both aerobic and anaerobic process, Medical waste disposal methods, treatment and reuse; Biotechnological approaches for management of e-waste. Biotechnological methods for cyanide, oxalate and urea detoxification; radioactive waste management. Environmental toxicology: Toxicants, Toxicity, Acute, subacute, chronic, dose effect and LD_{50} Dose response safe limits. Dose response relationship, detoxification of hazardous chemicals (naphthalene, cypermeythrin).

Unit V: Environmental Standards (15 hrs)

Biosafety guidelines in India, Environmental protection act [EPA] (1986): Overview, National Environmental policy, Role of OECD, Indian Water quality standards: Arghyam, BIS (Bureau of Indian Standards) role in good manufacturing practices and safe disposal of waste, Classification of water adapted in India (Class A, B,C,D & E), Recycling methods to be adapted home (preparation of home compost using bacteria source), industry (Agricultural waste to biofuel using yeast), Case studies (students assignments/ seminar/ debate) related to Environmental Biotechnology (Industrial, agricultural, food security).

REFERENCE BOOKS:

1. Devarajan Thangadurai and Jeyabalan Sangeetha, Industrial Biotechnology: Sustainable Production and Bioresource Utilization, CRC Press.
2. Loveleen Kaur, Rhobinka Khajuria, Industrial Biotechnology: Principles and application, Nova Science Publishers, 2015.
3. Nurhan Turgut Dunford, Food, Industrial bi-products and bioprocessing, Wiley-Blackwell, 2012.
4. Erick J.Vandamme, Jose Luis Revuelta, Industrial Biotechnology of vitamins, biopigments and antioxidants, Wiley-VCH, 1st Ed., 2016.
5. P.K. Chakraborty, Agro & Industrial Biotechnology, Black Prints India Inc., 2014.
6. Naha &Narain, Immuno-Biotechnology, Dominant Publishers & Distributors (P) Ltd., 2004.
7. Susanna, Biopharmaceutical Drug Design and Development, Humana Press, 1st Ed., 1999.

E-LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=f_wOnmjawiY
2. https://www.youtube.com/watch?v=1tJ2CWvTVGM&t=378s
3. https://www.youtube.com/watch?v=28iRLLXIBfU&t=292s
4. https://www.youtube.com/watch?v=hdpjA0XhYG0
5. https://www.youtube.com/watch?v=8_1Ng3SCvCU

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	2	2	1
III	2	2	1
IV	2	1	1
V	3	1	2
TOTAL	12	7	6
SECTION A – 12		**SECTION B – 7**	**SECTION C – 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	Correlate the SDG's	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	To illustrate the methods contributing to the pollution	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	Familiarize with various molecular techniques involved in wastage mitigation	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	To demonstrate the importance of pollution mitigation	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	To apply the pollution regulation of both State and National	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: B.Sc., Biotechnology	**Batch**: 2024-27
PART : III	**Course Component**: Elective-II
Course Name: Food Biotechnology	**Course Code**:
Semester: VI	**Marks**:100
Credits: 5	**Total Hours**: 75
Theory	

COURSE OBJECTIVES:

To address the awareness about the legal norms Indian and global level associated with food and to address the problems associated with food

COURSE OUTCOMES:

1. Recall the issue of malnutrition.
2. Understand the impact of Biotechnology in Indian food status.
3. Recall the identification of food that is produced based upon Biotechnological methods.
4. Familiarize the GMOs
5. Familiarize with the Food safety monitoring system.

Unit I: Basics of Food Biotechnology (15 hrs)

Importance and scope of food biotech and its application. Diseases pertaining to malnutrition in India; Impact of carbon food printing of food; Solution for malnutrition: Factors affecting meal planning, understanding specific considerations for planning meal for different groups of people.

Unit II: Biofortified Foods (15 hrs)

Definition and importance of Biofortification of crop and animals for food source. Microbes as food source (Pre and Probiotics foods); Methods of Biofortification of crop plants; Impact of biofortification in health improvement. Microbial plant-based food products: Microbial flavor (buttery, fruity), pigments (Astaxanthin, beta carotene, melanin) and fragrances (limonene, linalool, methone).

Unit III: Food Safety Regulations (15 hrs)

Food safety and standards: Food and Drug Administration (FDA), Food Standard Agency, HACCP, FSSAI and FCI (Indian Standards); Food labeling practices and needs, Universal and Indian standard codes, Laws related to food safety in India: Overview of 12 chapters and its related articles.

Unit IV: Food Storage and Preservation (15 hrs)

Role of microbes in Food spoilage (Dairy products) and Permissible limits of microbes in food (Dairy products). Principles involved in Food preservation and storage techniques (Dairy products). Treatment methods for solid and liquid wastes from food process industries (Dairy and meat industry).

Unit V: Agriculture and food ethics (15 hrs)

Food ethics to be followed: personal hygiene, environmental hygiene, kitchen hygiene, Agricultural ethics: Good agricultural practices for bio-fortified crop plant- rice. Laws for the production and use of genetically modified foods and global marketing, Sustainable development goals related to food: SDG-2, 3, 12, 14, 15 (case study).

REFERENCE BOOKS:

1. Byong H. Lee, Fundamentals of Food Biotechnology, John Wiley & Sons, Ltd., (2014).
2. S.C. Bhatia, Food Biotechnology, CRC Press (2016).
3. Chetan Sharma, Anil K.Sharma and K.R.Aneja, Frontiers in Food Biotechnology, Nova publishers, (2016).

E-LEARNING RESOURCES:

1. http://www.fao.org/docrep/U3550t/u3550t0h.htm.
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257668/

3. http://www.oecd.org/science/biotrack/41036698.pdf
4. https://www.youtube.com/watch?v=sOzt0D8vLCU
5. https://www.youtube.com/watch?v=BlHL5MxB84Q
6. https://www.youtube.com/watch?v=i610sLycTTs&list=PL_a1TI5CC9RE2S5RoMgcj2kv TmxqHgT gG
7. https://www.youtube.com/watch?v=-6ZY49DDvq4
8. Indian food safety law: 200634_food_safety_and_standards_act,_2006.pdf (indiacode.nic.in)

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

SECTION	QUESTION COMPONENT	NUMBERS	MARKS	TOTAL
A	*Answer any 10 out of 12 questions(each in 50 words)*	*1-12*	*3*	*30*
B	*Answer any 5 out of 7 questions(each in 300 words)*	*13-19*	*6*	*30*
C	*Answer any 4 out of 6 questions(each in 1200 words)*	*20-25*	*10*	*40*
TOTAL MARKS				**100**

BREAK UP OF QUESTIONS FOR THEORY

UNITS	SECTION A	SECTION B	SECTION C
I	3	1	1
II	2	2	1
III	2	2	1
IV	2	1	1
V	3	1	2
TOTAL	12	7	6
SECTION A – 12		**SECTION B - 7**	**SECTION C - 6**

PSO – CO mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO5
CO 1	3	3	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3
Ave.	3	3	3	3	3

PSO-CO-question paper mapping

CO No:	**COURSE OUTCOME**	**PSOs ADDRESSED**	**COGNITIVE LEVEL (K1 to K6)**
CO1	To recall the issue of malnutrition	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO2	To understand the impact of Biotechnology in Indian food status	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO3	To understand the identification of food that is produced based upon Biotechnological methods	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO4	To understand the GMOs	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6
CO5	To understand the Food safety monitoring system	PSO1, PSO2, PSO3, PSO4, PSO5	K1, K2, K3, K4, K5, K6

K1= Remember, K2= Understand, K3= Apply, K4=Analyse, K5= Evaluate, K6= Create

Programme: Biotechnology	**Batch**: 2024-27
PART : III	**Course Component**: Elective-III
Course Name: Group Project	**Course Code**:
Semester: VI	**Marks**:100
Credits: 5	**Total Hours**: 90
Theory	

	Internal Assessment	**External Assessment**
Project	**20 Marks** • Interaction with Guide - 5 marks • Regularity - 5 marks • Maintenance of project book – 10 Marks	**Project Report** – 50 Marks **Marks split for Project report:** • Title- 2 Marks • Introduction & Reviewof literature- 10 Marks • Methodology- 10 Marks • Results- 10 Marks • Discussion & Conclusion -10 Marks • Reference: 3 Marks • Neat presentation and Novelty- 5 **Viva Voce** – 30 Marks (Students can present the project using aspower point presentation)
Total=100 Marks	**20**	**80**

Evaluation of Group Project:
4 reviews periodically and as follows:
I - Review: Presentation of Problem statement
II - Review: 10% of research work
III - Review: 30% of research work
IV - Review: 75% of research work

SOFT SKILL COURSES

SOFT SKILLS	**BATCH:** 2024-27
COURSE NAME: Communication and Presentation Skills	**COURSE CODE:**
SEMESTER: I	**MARKS:**100
CREDITS: 2	**TOTAL HOURS:** 30

COURSE OBJECTIVE:

To build communication skills for personal and professional development.

COURSE OUTCOMES:

1. Students will demonstrate the ability to actively listen to others, understand diverse perspectives, and paraphrase key points accurately, enhancing their comprehension skills in various personal and professional contexts.
2. Students will be able to articulate thoughts, ideas, and information clearly and concisely, using appropriate language and structure to convey messages effectively in both written and verbal communication
3. Students will develop confidence in expressing opinions, asserting boundaries, and advocating for themselves and others, leading to enhanced self-assurance and effectiveness in interpersonal and group communication.
4. Students will learn to adapt their communication style and approach based on the audience, context, and purpose of communication, fostering flexibility and versatility in interacting with diverse individuals and groups.
5. Students will acquire techniques for resolving conflicts, managing disagreements, and negotiating mutually beneficial outcomes through effective communication strategies, promoting constructive problem-solving and collaboration in personal and professional settings.

UNIT I Types of Communication (6 hrs)

Verbal Communication - Nonverbal Communication - Visual Communication - Written Communication - Interpersonal Communication - Group Communication - Mass Communication - Digital Communication- Barriers – Language- Cultural- Psychological- Semantic- Technological Barriers

UNIT II Etiquette & Ethical Practices in Communication (6 hrs)

Active Listening - Respectful Language - Clarity and Conciseness – Truthfulness-Professionalism-Tone -Timeliness - Constructive Feedback - Confidentiality - Cultural Sensitivity - - Emotional Intelligence-Social Intelligence- Social Etiquettes-Accountability

UNIT III Self Actualization (6 hrs)

SWOC Analysis- Self Regulation-Self Evaluation, Self-Monitoring, Self- Criticism, Self-Motivation, Self-awareness and Reflection:

UNIT IV III Leadership and Teamwork (6 hrs)

Leadership Skills: Leadership styles- Goal-setting and decision-making- Motivation and influence-Team Dynamics: Team building activities- Conflict resolution- Collaborative problem-solving

UNIT V Stress and Time Management (6 hrs)

Definition of Stress, Types of Stress, Symptoms of Stress, Stress coping ability, Stress Inoculation Training, Time Management and Work-Life Balance: Self-discipline Goal-setting

PRESCRIBED BOOKS:

1. Goleman, Daniel (2006) *Emotional Intelligence*, Bantam Books
2. Linden, Wolfgang (2004) *Stress Management- From Basic Science to Better Practice*- University of British Columbia, Vancouver, Canada.

3. Hasson, Gill (2012) *Brilliant Communication Skills*. Great Britain: Pearson Education.
4. Monippally, Matthukutty, M. *Business Communication Strategies*. New Delhi: Tata McGraw-Hill Publishing Company Ltd., 2001.
5. Raman, Meenakshi & Sangeetha Sharma (2011*) Communication Skills*, Oxford University Press.

REFERENCE BOOKS:

1. N.Krishnaswamy *Current English for College* (1st Edition) - Trinity Press
2. Wood, Julia T (2015) *Interpersonal Communication: Everyday Encounters* 8th Edition,Cengage Learning.

E-LEARNING RESOURCES

1. http://www.albion.com/netiquette/corerules.html
2. http://www.englishdaily626.com/c-errors.php
3. https://www.helpguide.org/articles/relationships-communication/nonverbal-communication.htm
4. https://www.communicationtheory.org/verbal-vs-non-verbal-communication-with-examples/
5. https://letstalkscience.ca/educational-resources/backgrounders/digital-citizenship-ethics
6. https://www.switchboard.app/learn/article/teamwork-leadership-skills

GUIDELINES TO THE QUESTION PAPER SETTERS

QUESTION PAPER PATTERN

Section	Question Component	Numbers	Marks	Total
A	Answer any 5 out of 7 questions (answer in 50 words)	1-7	2	**10**
B	Answer any 4 out of 6 questions (answer in 300 words)	8-13	5	**20**
C	Answer any two(Internal (Choice)	14-15	10	**20**
	Internal & Viva Voce		50	**50**

BREAK UP OF QUESTIONS

UNITS	SECTION A	SECTION B	SECTION C
I	2	2	----
II	2	1	1
III	1	1	1
IV	1	1	1
V	1	1	1
TOTAL			
SECTION A - 12		**SECTION B - 6**	**SECTION C - 4**

SOFT SKILLS	**BATCH:** 2024-27
COURSE NAME: Interview Skills and Resume Writing	**COURSE CODE:**
SEMESTER: II	**MARKS:**100
CREDITS: 2	**TOTAL HOURS:** 30

COURSE OBJECTIVE:

To equip the students to acquire the relevant skills for better employability.

COURSE OUTCOMES:

1. Students will gain an overall understanding of the concept, the purpose, and the objectives of an interview
2. Students will become aware of the various types of interviews and the nuances of each one of them
3. Students will understand and equip themselves with the techniques and strategies required to ace an interview
4. Students will be able to draft a biodata /CV/Resume in the proper format
5. Students will embark on acquiring the relevant skills and will learn to leverage them effectively for better employability

UNIT I Introduction to Interview Skills (6 hrs)

Definition- meaning- concept of interview –Purpose- Objectives of interview-Characteristic features of job interviews

UNIT II Types of Interview (6 hrs)

Traditional one on one job interview- Panel interview- Behavioral interview-Group interview-Phone Interview- Preliminary Interview-Patterned Interview Depth Interview, Stress Interview, Exit Interview- Interview through tele and video conferencing

UNIT III Interviews: Techniques and Strategies (6 hrs)

Preparing for the Interview Process- Before the interview-During the interview-After the interview -Tips to ace an interview -Commonly asked questions in interview -Do's and Don'ts of interview - Reasons for rejections

UNIT IV Preparing Biodata/CV/Resume (6 hrs)

Essential characteristics of a job Application-Difference between Biodata- CV-Resume-covering letter-Tips to draft an application

UNIT V Leveraging Employability Skills (6 hrs)

Personality Development-Organizational skills-Time Management–Stress Management-Effective Communication Skills -Reasoning Ability-Verbal Ability- Group Discussion-Technical skills - Presentation skills

PRESCRIBED BOOKS

1. Monipally, Matthukutty M. (2017) *Business Communication: From Principles to Practice*
2. Peter, Francis. (2012) *Soft Skills and Professional Communication*. New Delhi: Tata McGraw Hill.

REFERENCE BOOKS

1. Higgins, Jessica JD (2018)*10 Skills for Effective Business Communication: Practical Strategies from the World's Greatest Leaders*
2. Nicholas, Sonji (2023) *Interviewing: Preparation, Types, Techniques, and Questions,* Pressbooks
3. Storey, James (2016) *The Art of The Interview: The Perfect Answers to Every Interview Question*

E-LEARNING RESOURCES

1. https://careermobilityoffice.cs.ny.gov/cmo/documents/Resume%20&%20Interviewing%20Handout.pdf
2. https://edu.gcfglobal.org/en/interviewingskills/interview-etiquette/1/
3. https://findjobhub.com/en/types-of-interviews
4. https://egyankosh.ac.in/bitstream/123456789/23411/1/Unit-2.pdf
5. https://bharatskills.gov.in/pdf/E_Books/CTS/ES/English/ES_Part_1_62%20hour_English.pdf
6. https://bharatskills.gov.in/pdf/E_Books/CTS/ES/English/ES_Part2_58hour_English.pdf

GUIDELINES TO THE QUESTION PAPER SETTERS
QUESTION PAPER PATTERN

Section	Question Component	Numbers	Marks	Total
A	Answer any 5 out of 7 questions (answer in 50 words)	1-7	2	**10**
B	Answer any 4 out of 6 questions (answer in 300 words)	8-13	5	**20**
C	Answer any two(Internal (Choice)	14-15	10	**20**
	Internal & Viva Voce		50	**50**

BREAK UP OF QUESTIONS

UNITS	SECTION A	SECTION B	SECTION C
I	2	2	----
II	2	1	1
III	1	1	1
IV	1	1	1
V	1	1	1
TOTAL			
SECTION A - 12		**SECTION B - 6**	**SECTION C - 4**

PROGRAMME: For All Non IT students	**BATCH:** 2024-27
PART: IV	**COURSE COMPONENT:** Soft Skill-3
COURSE NAME: Digital Proficiency and Multimedia Skills	**COURSE CODE:**
SEMESTER: III	**MARKS:**100
CREDITS: 2	**TOTAL HOURS:** 30
PRACTICAL	

(Common to non IT Students)

COURSE OBJECTIVE:

To equip students with essential computing skills.

COURSE OUTCOMES:

1. Design document using salient features of MS-Word.
2. Utilize MS-Excel to manipulate data and prepare dynamic presentation using MS-Power Point.
3. Develop a static web page using HTML.
4. Exhibit proficiency in multimedia creation using GIMP.
5. Demonstrate expertise in data visualization with Raw Graphs.

UNIT 1: **(6 hrs)**

MS-Word: Creating, Editing, Formatting and Printing of Documents - Headers and Footers -Spell check- Insert/Draw Tables, Table Auto format – Page Borders and Shading - Mail Merge.

MS-Excel: Creating a new worksheet – Entering, editing and formatting the text, numbers – Formatting cells.

UNIT 2: **(6 hrs)**

Inserting Rows/Columns - Changing column widths and row heights – Freezing Titles, splitting screen - Formulae for calculation - Changing font sizes and colours, Sort.

MS-PowerPoint: Creating a Presentation - Inserting and Deleting Slides in a Presentation – Adding Text/Clip Art/Pictures - Slide Transition – Custom Animation.

UNIT 3: **(6 hrs)**

Web designing using HTML: Basic tags – heading tags – paragraph, bold, italic, underline tags – font tags – ordered and unordered list – inserting images – hyperlinks.

UNIT 4: **(6 hrs)**

Multimedia applications using GIMP: Interface and Drawing Tools in GIMP- Applying Filters - Creating and handling multiple layers - Using Stamping and Smudging tools - Importing pictures.

UNIT 5: **(6 hrs)**

Data visualization using Raw Graphs: Importing and exploring data - Basic chart types -mapping - customizing visualizations - Exporting visualizations.

E-LEARNING RESOURCES:

1. https://www.javatpoint.com/ms-word-tutorial
2. https://www.w3schools.com/excel/
3. https://www.tutorialspoint.com/html/
4. https://www.gimp.org/tutorials/
5. https://www.rawgraphs.io/learning

PROGRAMME: ALL UG	**BATCH:** 2024-27
PART: IV	**COURSE COMPONENT:** Soft Skill-4
COURSE NAME: Foundations of Quantitative Aptitude	**COURSE CODE:**
SEMESTER: IV	**MARKS:**100
CREDITS: 2	**TOTAL HOURS:** 30
THEORY AND PROBLEMS	

COURSE OBJECTIVE:

To develop learners' problem-solving skills and critical thinking abilities in the context of recruitment aptitude tests.

COURSE OUTCOMES:

1. The learner will be able to recognize, describe and represent patterns and relationships, as well as to solve problems using algebraic language and skills.
2. To learn about factors and multiples that numbers have in common with each other.
3. The student will analyse monthly profit and loss statements for a school store and calculate profit margin percentages.
4. Students learn what different types of interest are, where it occurs in real life and understand the concept of simple and compound interests.
5. The learner will draw, interpret and compare pie charts, bar charts and frequency diagrams.

UNIT I: Number system and Number series (6 hrs)

Numbers: Numbers and their classification, test for divisibility of numbers, General properties of divisibility, division and remainder, remainder rules.

Number Series: Number series, three steps to solve a problem on series, two-line number series, sum rules on natural numbers.

UNIT II: HCF and LCM of Numbers (6 hrs)

Factors, Multiples, Principal of Prime factorization, Highest Common Factor (HCF) and Least Common Multiple (LCM), Product of two numbers, Difference between HCF and LCM.

UNIT III: Percentage, Profit and Loss (6 hrs)

Percentage: Introduction, fraction to rate percent, rate percent to fraction, rate percent of a number, express a given quantity as a percentage of another given quantity, convert a percentage into decimals and convert a decimal into percentage.

Profit and Loss: Gain/Loss and % gain and % loss, relation among Cost price, Sale price, Gain/Loss and % gain and % loss.

UNIT IV: Simple Interest and Compound Interest (6 hrs)

Simple Interest: Definition, effect of change of *P, R and T* on Simple Interest, amount.

Compound Interest: Introduction, conversion period, basic formula, to find the Principal/Rate/Time, Difference between Simple Interest and Compound Interest.

UNIT V: Data interpretation **(6 hrs)**

Tabulation, Bar Graphs, Pie Charts, Line Graphs, average.

PRESCRIBED BOOK:

1. Quantitative Aptitude by R.S. Agarwal

REFERENCE BOOKS:

1. Quantitative Aptitude by Abhijit Guha, Fourth Edition.
2. Quantitative Aptitude by Ramandeep Singh.

E - LEARNING RESOURCES:

1. https://byjus.com/maths/numeral-system/#:~:text=crore%20is%207.-,International%20Numeral%20System,8%20%E2%80%93%20Ones
2. https://byjus.com/maths/hcf-and-lcm/
3. https://byjus.com/maths/profit-loss-percentage/
4. https://www.vedantu.com/jee-main/maths-difference-between-simple-interest-and-compound-interest
5. https://sites.utexas.edu/sos/guided/descriptive/descriptivec/frequency/

Certificate Courses

Certificate Courses Offered to the students of Biotechnology and other department interested students

Each course Duration: 30 hrs.

Batch strength: 15 students (based upon the demand the Programme can be re-run)

1. **Certificate Course- I: Biosafety pertaining to the field of Life Science**

   Course Objective:

   - To familiarize with the Biosafety guideline at National and Global status
   - Suitable for the following job roles: Biosafety officer, WHS (work, health, safety) Officer

   Course Outcomes:

   - Understand the meaning of Biosafety
   - Demonstrate the need for Biosafety guidelines
   - Compile the Biosafety levels
   - Familiarize with the ICMR Biosafety guideline

   Unit-I: Scope of regulation **(6hrs)**

   Unit-II: Principles and components of Contaminants **(6hrs)**

   Unit-III: Biosafety components **(6hrs)**

   Unit-IV: Operational guidelines on Contaminants and containment for large scale operations of genetically engineered (GE) microorganisms Risk assessment in Biotechnological research **(6hrs)**

   Unit-V: Containment requirement for import, export and exchange and ICMR guidelines concerned with Biosafety **(6hrs)**

   Reference: MergedFile (dbtindia.gov.in)

2. **Certificate Course: II: Science communication**

   Course Objective:

   - Support for career in Science communication
   - Suitable for the following job roles: Soft ware developer, Column writer in print media, Customer care specialist in Pharmaceutical industry, Public programme developer, Medical Writer for Clinical Trial, Medical Science Liaison officer

   Course Outcomes:

   - To introduce science communication in the broader contexts of (a) the role of communication in science, and (b) the cultural, practical and policy-related role of science communication in wider society
   - To provide intellectual resources for constructive critical analysis of popular science communication in a variety of real-world settings
   - To cultivate students' practical communication skills, with particular emphasis on effective speaking, writing and exhibiting on scientific and science-related topics to a variety of audiences;

   Unit-I: Importance of Science Communication and communicator **(6 hrs)**

   Unit-II: Practical: Scientific words used in a Science communication **(6 hrs)**

   Unit-III: Science in the today's media **(6 hrs)**

   Unit-IV: Visualizing Science for Communication **(6 hrs)**

   Unit-V: Projects: Reviews for New paper published article, to prepare a case study for environmental pollution, to prepare a case study for latest Scientific innovation/ invention **(6 hrs)**

3. **Certificate Course-III: Quality control in the Pharmaceutical industry**

   Course Objective:

   - To understand the quality control of bioproducts in pharmaceutical industry
   - Suitable for the following job roles: QC technicians, QC analyst, Quality assurance executive/ Manager

Course Outcomes:

- Demonstrate the QC in pharmaceutical industry
- Familiarize with the types of QC adapted in pharmaceutical industry
- Know- how of QC in pharmaceutical industry
- Develop QC for pharmaceutical industry
- Familiarize with the various Indian accreditation agencies related to pharmaceutical industry

Unit-I: Testing and Calibration Procedures, Total Quality Assurance, Quality Control, Quality Planning. **(6 hrs.)**

Unit-II: Laboratory Management Procedure, Lab Information Management System, Validation of Equipment and Safety Protocols. **(6 hrs.)**

Unit-III: Fish borne diagram for Pharma QC, Quality Audit Definition, Types of Audit - Internal Audit and External Audit, Need of Audit, Importance of Audit and product significance **(6 hrs)**

Unit-IV: QC for biological derived product and Accreditation & Certificate NABL, ISO, IEC & BIS - Introduction & Relevant Provisions **(6 hrs)**

Unit-V: Indian Pharmacopoeia Commission (IPC) and QC related to pharmaceutical, cosmetic, nutraceutical. **(6 hrs)**

4. Certificate Course- IV: Quality assessment and assurance in dairy industry

Course Objective:

To familiarize with the Quality control adapted in dairy industry

- Suitable for the following job roles: QC technicians, QC analyst, Quality assurance executive/ Manager

Course Outcome:

- To understand about the food safety management system and create awareness among the students about consumer welfare on microbiological quality and safety of dairy foods.
- To understand the basic procedure and principles of quality and safety management involved in processing of dairy foods in industry.

Unit-I: All dairy related products, permissible limit of microbes in the dairy products, possible biological and non-biological contaminants **(6 hrs.)**

Unit-II: Concept of quality, safety, and food laws in India **(6 hrs.)**

Unit-III: Food safety and quality management systems **(6 hrs.)**

Unit-IV: Quality evaluation by HACCP in the preparation of dairy products **(6 hrs.)**

Unit-V: Microbiological techniques and analysis **(6 hrs.)**

Ref: Final AAU Souvenir for Web 9-1-15.pdf (dairyknowledge.in)
MICROBIOLOGICAL-QUALITY-AND-SAFETY-IN-DAIRY-INDUSTRY-Book.pdf (agrimoon.com)

5. Certificate Course- V: Intellectual property rights

Course Objective:

To familiarize with Indian IPR policies

Suitable for the following job roles: IP Field agents, IP Counsel, IP-Deputy manager, Business development executive, Legal content moderator

Course Outcome:

- Recall the fundamentals of IPR
- Familiarize the patent law, copy right, trademarks, design, geographical indicators of both at Global and National levels.
- Familiarize the recent amendments in the IPR laws.

Unit-I: Introduction to IPR **(6 hrs)**

Unit-II: Components of IPR **(6 hrs)**

Unit-III: Patents and Copy rights **(6 hrs)**

Unit-IV: Trademarks, designs and Geographical indicators **(6 hr)**
Unit-V: Indian patent law-1970 and 2016 **(6 hrs.)**

6. Certificate Course- VII: Bioentrepreneurship

Course Objective:

The field of Biotechnology must be learnt as a congregation of both research and business and thus the certificate course objective is to focus upon broad view of Bioentrepreneurship.

Course Outcome:

- Recall Bioentrepreneurship.
- Apply the concepts of Bioentrepreneurship
- Analyze the pros and cons of Bioentrepreneurship
- Organise the business ideas
- Familiarize with existing Biosectors

Unit-I: Bioentrepreneurship (6 hrs)

Scope of Bioentrepreneurship in India, Types of Bioentrepreneurship, Abilities of Bioentrepreneurship: Educational Qualification, Technical skills, Experiential learning, Types of Enterprises: Public sector enterprises, Private sector enterprises and joint sector

Unit-II: Business model development (6 hrs)

Perceiving and identification of opportunities: a. Identification of problem statement in society, innovative solutions, Bioentrepreneurial opportunities, Business environment: Micro and Macro environments, lateral business development, finance management. Direct and indirect taxation.

Unit-III: Bioentrepreneurial Opportunity and Planning (6 hrs)

Transformation ideas into opportunities, Idea and opportunities analyses: a.Protype development and creation of a business model, b. Understanding the market feasibilities, Levels of operation, Accreditation bodies for testing and licensing.

Unit-IV: Indian Bioentrepreneurial programmes (6 hrs)

Spin-off, Traditional out-licensing of technology or IP, Trade sale, Internal development, Incubation, Collaboration/Partnership/Joint venture, Indian Bioentrepreneurial development schemes: MSME, DBT, BIRAC, Make in India, Start-up

Unit-V: Commercialisation process and strategies (6 hrs)

Biotechnology product value chain, Market for ideas vs market for products, Introduction of E-Commerce and legal provisions, Technological innovations vs business models, Process of commercialisation: customer valuation, identification of fund for large production, Amplification of value and reduction of uncertainty. Information Technology Act-2000.

Reference:

ENTREPRENEURSHIP (biotech.co.in)

Evaluation Pattern of the certificate course

The evaluation pattern for each course can be conducted as per the below mentioned regulations:

- MCQ: 50 %
- Oral presentation of case study: 25%
- Group discussions:15 %
- Assignments: 10%

Total: 100 marks

Self – Study Courses

INDIAN HERITAGE AND KNOWLEDGE SYSTEM

PROGRAMME: For all UG Programmes	**BATCH:** 2024-27
PART: IV	**COURSE COMPONENT:** Self Study Course
COURSE NAME: Indian Heritage And Knowledge System	**COURSE CODE:**
SEMESTER: III	**MARKS:**100
CREDITS: 2	
QUESTION PATTERN: MCQ	
THEORY	

COURSE OBJECTIVES:

To delve into Indian Heritage, this course focuses on South Indian cultures and ancient knowledge like Yoga, Ayurveda, and Siddha, shaping the Nation's identity.

COURSE OUTCOMES:

1. To develop a comprehensive understanding among students of Indian heritage, its richness and diversity, and its role in shaping the nation's cultural identity.
2. Students will gain an enhanced insight into the artistic, architectural, and literary achievements of South India and other regions, fostering a sense of pride in Indian cultural heritage.
3. To enhance students' cultural literacy by gaining insights into traditional practices preserved through folklore across India.
4. To acquire knowledge among students of ancient Indian sciences for holistic well-being, promoting physical, mental, and spiritual health.
5. Students will develop a deeper understanding of the interconnectedness of spiritual, medicinal, and artistic dimensions within Indian Heritage systems.

UNIT I: Introduction to Indian Heritage

- **Concept of Heritage:** Definition, the importance of studying heritage, and its diverse forms.
- **Cultural Landscape of India:** Overview of major cultural zones in India, with a focus on South India.

  Key Concepts: Cultural heritage, diversity, tangible heritage (e.g., monuments), intangible heritage (e.g., traditions, practices).

UNIT II: Cultural Tapestry of South India

- **Literature:** The classical Tamil literature of *Sangam poetry*, the epic Kannada works like the *"Kuvempu Ramayana,"* the Telugu compositions of *Annamacharya,* and the poetic Malayalam works of Kerala's rich literary tradition.
- **Painting:** The intricate gold leaf work of *Tanjore* painting, the intricate patterns of *Mysore* painting, hand-painting or block-printing of Kalamkari.
- **Theatre:** The ancient art form of *Koothu* and the elaborate dance-dramas of *Bhagavata Mela* in Tamil Nadu, and the colourful folk theatre of *Yakshagana* in Karnataka.
- **UNESCO Indian Heritage Sites:** *Great Living Chola Temples* artistry, *Hampi*-Virupaksha Temple and the Vijaya Vittala Temple, *Mahabalipuram*- a treasure trove of Pallava art, *Mysore Palace*-Indo-Saracenic architecture, *Periyar National Park*- Western Ghats, *Kanchipuram*-City of Thousand Temples

UNIT III: Tamil Nadu Folklores

- **Origins and Significance:** Historical background of Tamil Nadu folklore and its cultural significance.
- **Folk Dances:** Exploration of traditional Tamil folk dances like *Karakattam, Kolattam,* and *Kummi.*
- **Folk Music:** Overview of folk music traditions in Tamil Nadu, including *Parai Attam and Villu Paatu.*
- **Rituals and Festivals:** Understanding the role of folklore in Tamil Nadu's rituals and festivals- *Pongal and Jallikattu.*

  Key Concepts: Karakattam, Kolattam, Parai Attam, Villu Paatu, Tamil folk tales, cultural rituals.

UNIT IV: Unveiling the Knowledge Systems

- **Cultural Landscape of India:** Overview of major cultural zones in India, with a focus on South India.
- **Yoga:** Exploring the various aspects of Yoga - its philosophy, Eight Limbs, practices (e.g., Asanas, Pranayama), and benefits for physical and mental well-being.
- **Ayurveda:** Understanding the core principles of Ayurveda - its focus on holistic health, diagnosis, and treatment methods.

  Key Concepts: Yoga philosophy, Asanas, Pranayama, Tridosha theory (Ayurveda), Doshas (Vata, Pitta, Kapha), Panchakarma, herbal medicine, Ayurvedic lifestyle.

UNIT V: Siddha Tradition and Other Knowledge Systems

- **Siddha Tradition:** Origins, philosophy, medicinal practices, and spiritual aspects.
- **Other Important Knowledge Systems:** Jyotish Shastra (Indian astrology), Natya Shastra (Treatise on performing arts).

  Key Concepts: Siddha literature, alchemy, and spirituality in Siddha tradition. Pancha Boothas (Siddha), herbal remedies, Planetary influences, elements of classical Indian dance and music, and aesthetics in Natya Shastra.

CONTEMPORARY WORLD AND SUSTAINABLE DEVELOPMENT

PROGRAMME:	**BATCH:** 2024-27
PART: III	**COURSE COMPONENT:** Self Study Course
COURSE NAME: Contemporary World and Sustainable Development	**COURSE CODE:**
SEMESTER: III	**MARKS:**100
CREDITS: 2	
QUESTION PATTERN: MCQ	
THEORY	

COURSE OBJECTIVES:

To delve into global dynamics, this course highlights Asia and India's pivotal role in achieving global sustainability objectives.

COURSE OUTCOMES:

1. Students will gain a comprehensive understanding of the key actors, institutions, and dynamics shaping the contemporary world order.
2. Students will acquire the ability to analyze the political, economic, and security challenges within major Asian regions, fostering informed perspectives on these critical issues.
3. Through the study of recent wars, students will develop critical thinking skills to assess the root causes, human costs, and potential solutions to contemporary conflicts.
4. Students will gain a deeper understanding of the principles and challenges of sustainable development, empowering them to advocate for responsible solutions at local, national, and international levels.
5. Students will be equipped to critically evaluate India's contributions to the SDGs, particularly through specific programs implemented in Tamil Nadu, and assess their effectiveness in achieving sustainable development goals.

UNIT I: Global Governance and Institutions

- **State & Non-State Actors:** Definition, types (nation-states, failed states), functions.
  Key Actors: International states, Intergovernmental organizations (IGOs), nongovernmental organizations (NGOs), multinational corporations (MNCs).
- **United Nations (UN):** Structure, key organs (General Assembly, Security Council), functions, WB, & others.
  Key Concepts: United Nations General Assembly, United Nations Security Council.
- **Regional Organizations:** European Union (EU), African Union (AU), North Atlantic Treaty Organization (NATO)
  Key Concepts: European Union Commission, African Union Commission, North Atlantic Treaty Organization.
- **International Law and Treaties:** Significance, role in addressing global challenges.
  Key Concepts: International Court of Justice, International Criminal Court, Geneva Conventions.

UNIT II: Contemporary Asia

Major Geographical Regions

- **Middle East:** Characterized by rich oil reserves, Complex political dynamics, and ongoing conflicts.

Key countries: Iran, Iraq, Israel, Saudi Arabia, Syria, Turkey

- **Southeast Asia:** Rapid economic growth, Challenges- maritime security and environmental degradation.
  Key countries: Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam
- **Far East:** Major economic powerhouses and Potential flashpoints.
  Key countries: China, Japan, North Korea, South Korea
- **Rise of China:** Political-South China Sea, Territorial disputes and Competition for Resources. Economic- China's Belt and Road Initiative (BRI)
- **Major Economic Centers: Singapore-** Global financial hub, **Hong Kong-** Special Administrative Region of China, **United Arab Emirates (UAE)-** Diversified economy driven by oil and gas, tourism, and trade.

Regional Organizations:

- Association of Southeast Asian Nations (ASEAN)
- South Asian Association for Regional Cooperation (SAARC)
- Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)
- Asia-Pacific Economic Cooperation (APEC)
- Shanghai Cooperation Organization (SCO)

UNIT III: Recent Wars of the World

- **Syrian Civil War (2011-present):** Bashar al-Assad regime, Syrian opposition groups, ISIS.
  Key Concepts: Origins of the conflict, humanitarian crisis, foreign intervention, refugee crisis.
- **Yemeni Civil War (2015-present):** Houthi rebels, Yemeni government, Saudi-led coalition.
  Key Concepts: Proxy war dynamics, humanitarian crisis, role of Iran and Saudi Arabia, UN peace efforts.
- **Ukraine Conflict (2014-present)**: Ukrainian government, Russian-backed separatists, Russia.
  Key Concepts: Annexation of Crimea, Donbas region conflict, Minsk agreements, NATO-Russia tensions.
- **Ethiopia Civil War (2020-present):** Ethiopian government, Tigray People's Liberation Front (TPLF), Eritrean forces.
  Key Concepts: Tigray conflict, humanitarian crisis, regional implications, efforts for ceasefire and peace talks.
- **Nagorno-Karabakh War (2020):** Armenia, Azerbaijan, Russia.
  Key Concepts: Conflict over Nagorno-Karabakh region, ceasefire agreement, role of Turkey, peace negotiations.
- **Myanmar Civil War (2021-present):** Myanmar military (Tatmadaw), ethnic armed groups, and Civilian resistance.
  Key Concepts: Coup aftermath, Rohingya crisis, ethnic conflicts, ASEAN mediation efforts.

UNIT IV: Sustainable Development Goals

- **Definition of Sustainable Development:** Balancing economic, social, and environmental needs.
  Key Concepts: United Nations Development Programme (UNDP), World Wildlife Fund (WWF), Sustainable Development Solutions Network (SDSN).
- **UN Sustainable Development Goals (SDGs):** Overview, targets.
  Key Concepts: United Nations, national governments, NGOs, private sector.
- **Challenges and Opportunities:** Achieving sustainability, global cooperation.
  Key Concepts: United Nations, national governments, civil society organizations, multinational corporations.

UNIT V: India's Role in Achieving Sustainable Development Goals (SDGs) with Tamil Nadu Initiatives

Addressing Basic Needs:

- **Goal 1: No Poverty**
  - National Rural Employment Guarantee Act (NREGA)

    - Kalaignar Kanchi Thalaiyalar Scheme
    - Ungal Thozhil Udhayanam (UTOY)
- **Goal 2: Zero Hunger**
    - National Food Security Act (NFSA)
    - Nutritious Noon Meal Programme
    - Annadhanam Scheme
    - Amma Unavagam
- **Goal 3: Good Health and Well-being**
    - National Health Mission (NHM)
    - Health Insurance of Tamil Nadu
    - Chief Minister's Comprehensive Health Insurance Scheme
    - Maruthuva Mitri
    - Amma Mini Clinics

Ensuring Essential Services:

- **Goal 4: Quality Education**
    - Sarva Shiksha Abhiyan (SSA)
    - Rashtriya Madhyamik Shiksha Abhiyan (RMSA)
    - Namakkal District Library Scheme
    - Pudhumai Penn Scheme under Higher Education Assurance Scheme (HEAS)
    - Free Coaching for Competitive Exams
- **Goal 6: Clean Water and Sanitation**
    - Swachh Bharat Mission (Clean India Mission)
    - National Rural Drinking Water Programme (NRDWP)
    - Jal Jeevan Mission Tamil Nadu
    - Namakku Naathey Scheme
    - Kudimaramathu Scheme
- **Goal 7: Affordable and Clean Energy**
    - National Solar Mission
    - Tamil Nadu Solar Energy Policy
    - Green House Scheme

Building Sustainable Communities:

- **Goal 11: Sustainable Cities and Communities**
    - Smart Cities Mission
    - Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
    - Adi Dravidar Housing Scheme
- **Goal 13: Climate Action**
    - National Action Plan on Climate Change (NAPCC)
    - International Solar Alliance
    - Tamil Nadu Wind Energy Policy 2019
- **Goal 17: Partnerships for the Goals**
    - Development Assistance Programmes (DAPs)
    - International Development Cooperation (IDC)