

SANKALCHAND PATEL UNIVERSITY, VISNAGAR

Faculty of Science and Humanities



**Structure, Teaching Scheme and Syllabus of
B.Sc. (Biotechnology) Honours with Research**

Sem-6 as per NEP 2020

Program Code: SC101

With effect from: 2023-24

SEMESTER-6

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Immunological Disorders
Course Code:	16-BIM304-3C
Pre-requisite Course:	

Course Objectives:

- ☐ The course is designed to acquire basic knowledge of hypersensitivity and autoimmunity.
- ☐ This will enable the student to understand basics of autoimmune diseases.
- ☐ This course is designed to enable students in understanding the basics and applications immune systems, cancer and organ transplantation.

Teaching and Examination Scheme:

Teaching Scheme(Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	- Hypersensitivity: Immediate and delayed hypersensitivity - Autoimmunity: Immunotolerance and autoantigens - Organ Specific Autoimmune Diseases: Grave's disease and Pernicious anemia - Systemic Autoimmune Diseases: Multiple sclerosis and Rheumatoid arthritis	15	34%
2	- Immunodeficiency diseases: Congenital/Primary and Acquired/Secondary - Immune Response to infectious Diseases: Viral Infections, Bacterial Infections, Protozoan Infections, Helminth Infection	15	33%
3	Tumor Immunity: Oncogenes and Cancer Induction. Cancer Immunotherapy. Transplantation Immunity: Host Vs graft, Graft Vs host Reaction, Immuno Suppression, organ transplantations	15	33%

Text Books: Kuby's Immunology: R.A.Goldsby, T.J.Kindt and B.A.Osborne

Reference Books:

- Atlas, R.M. (1997) Principles of Microbiology. (2nd ed.). Win. C Brown Publishers. Dubuque.
- Prescott, L.M., Harley, J.P., Klein. DA., (2002) Microbiology (5th edY McGraw Hiil. International ed.
- Tortora, G.J., Funke, B.R., Case, C.L. (2001) Microbiology: An Introduction. (7th ed). Benjamin Cummings N.Y.
- Essential Immunology: Ivan Roitt
- Immunology: I.Roitt, Brostoff, Mole
- Introductory Immunology: How Davies
- Immunology Introductory Text Book Shetty Nandini

List of Open-Source Software/learning website: <https://www.youtube.com/watch?v=HNOcQKwW5ks>

List of Experiments:

1. Analyze the underlying mechanisms and clinical implications of hypersensitivity reactions.

2. Explain the principles of immunotolerance and the role of autoantigens in autoimmune responses.
3. Investigate the causes, symptoms, and treatment strategies for various immunodeficiency conditions.
4. Evaluate the principles and applications of cancer immunotherapy.
5. Learn the mechanisms and applications of immunosuppression in organ transplantation.
6. Visit to AIDS and/or Cancer research centre.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Students will gain an understanding of hypersensitivity and autoimmunity.	2 Understanding
CLO2	Identify and categorize various types of autoimmune diseases.	1 Remembering
CLO3	Understand the mechanisms and implications of immunodeficiency diseases.	2 Understanding,
CLO4	Learn foundational techniques to diagnose and interpret autoimmune diseases.	3 Applying, 2 Understanding
CLO5	Explore immune responses to infectious diseases and tumor immunity.	5,3, 4 Evaluate,Applying, Analyze
CLO6	Acquire fundamental knowledge and apply it to comprehend autoimmune disorders.	6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	2	1	2	1	3	2	1	2	1	1	3	2	2	2	1	2	1	2	3
CLO2	3	1	3	1	1	2	1	2	2	1	1	1	2	1	2	2	2	3	2
CLO3	2	1	2	2	1	3	2	1	1	2	2	1	2	2	1	1	1	1	1
CLO4	2	2	2	2	1	1	1	2	1	2	3	2	3	1	3	2	3	2	3
CLO5	2	1	1	1	3	3	1	1	2	1	2	1	2	3	2	1	1	3	3
CLO6	1	2	1	1	3	1	1	2	1	2	1	2	1	1	2	1	3	1	2

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Industrial Biotechnology
Course Code:	16-BIM305-3C
Pre-requisite Course:	Biotechnology

Course Objectives:

- To understand fermentation process and strain improvement
- To understand Medium formulations for industry
- To understand Design of fermenter
- To understand downstream processing

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Introduction to fermentation and strain improvement Concept of Fermentation, Range of fermentation processes, component parts of fermentation process. Growth kinetics: Batch, fed-batch and continuous culture (chemostat and turbidostat) Isolation, Enrichment & screening (Primary & Secondary) of Industrial Important Microorganisms. Preservation techniques Strain Improvement: Induced mutants for primary and secondary metabolites, Application of r-DNA technology for strain improvement.	13	28
2	Concept of fermentation media and inoculum development Medium formulations for industry and types (crude and synthetic) of fermentation media Raw materials used in fermentation media and criteria for selection, Batch and Continuous sterilization, Del factor, Sterilization of Media & Air Inoculum Development: Typical Inoculum Development program, Inocula development for Bacteria, Yeast and Fungal processes. Scale-Up	13	28
3	Design of fermenter Design of fermentor :Basic function of typical fermenter Design of ideal STR and various auxillary parts(aeration, agitation and body construction) Aseptic operations and Containments Types of fermenters: Tower, Cylindroconical, Air lift, Acetator Cavitator, Bioreactors for animal cell cultures Downstream processing. Removal of Solid & Microbial Cells and other solid Matter, Foam separation, Precipitation, Filtration and Centrifugation Cell disruption Concentration of extracted product: Liquid-Liquid extraction, Distillation, Purification products: Chromatography, Membrane processes and ultra filtration Drying & Crystallization, Quality Assurance-Bioassay	19	44

Text books:

1. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India
2. Stanbury and Whitaker. Principles of fermentation technology.

Reference Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction.9th Edition. Pearson Education
3. Biotechnology –The Biological Principles, M.D.Trevaan , S.Boffey, K H Goulding, P Stanbury

List of Open-Source Software/learning website:

- <https://www.youtube.com/watch?v=PLpfVLg5f08>
- https://www.youtube.com/watch?v=hav_yLrgFqs
- <https://archive.nptel.ac.in/courses/102/105/102105058/>

List of Experiments:

1. Screening and Isolation of Amylase producing microorganisms from soil.
2. Screening and Isolation of Protease producing microorganisms from soil.
3. Screening and Isolation of Lipase producing microorganisms from soil.
4. Screening and Isolation of antibiotic producing microorganisms from soil by crowded plate method
5. Screening and Isolation of antibiotic producing microorganisms from soil by Wilkin's method
6. Screening and Isolation of organic acid producing microorganisms from soil.
7. Sterility testing of pharmaceutical products.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understanding the concept of fermentation, enlist various Range of fermentation and Parts of fermenter	1 Remembering 2 Understanding
CLO2	Discuss growth of microbes and the control of biosynthetic pathway.	1 Remembering ,2 Understanding ,3 Applying
CLO3	Discuss various design of fermenter, Overview of downstream processing in which students will have knowledge of purification of microbial products.	1 Remembering , 2 Understanding 3 Applying
CLO4	Describe and compare various methods of Isolation, Enrichment, screening & preservation techniques of Industrial Important Microorganisms. Strain Improvement	1 Remembering 2Understanding 3 Applying 4 Analyse
CLO5	Discuss types of media and ingredients used in production media its advantages and disadvantages for medium formulations, for industry,	1 Remembering 2 Understanding 3 Applying 4 Analyse 5 Evaluate 6 Create
CLO6	Evaluate and compare different methods of sterilization, inoculums development processes and Scale-Up	1 Remembering 2 Understanding 3 Applying 4 Analyse 5 Evaluate 6 Create

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	3	2	1	1	3	2	1	3	1	1	3	1	3	2	3	2	2	2	3
CLO2	2	1	3	2	1	2	3	2	2	1	3	2	1	1	1	2	2	1	3
CLO3	3	1	2	2	1	3	2	1	1	2	2	2	2	2	1	1	1	3	2
CLO4	2	2	3	2	1	2	2	2	1	2	1	2	1	1	2	2	2	2	3
CLO5	3	1	1	1	2	3	1	1	2	1	2	3	3	3	2	2	2	2	2
CLO6	2	3	1	1	2	3	1	2	1	2	1	2	2	1	2	1	1	1	3

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Bioprocess and Biochemical Engineering
Course Code:	16-BIM306-3C
Pre-requisite Course:	Biotechnology

Course Objectives:

- To understand Microbial processes and production
- To understand Fermentation processes
- To understand Biosensors
- To understand Fermentation economics

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Mushroom cultivation Microbial processes in industry: -bioleaching and MEOR Microbial processes in agriculture: bio insecticide and bio-fertilizer Microbial production Bioplastic Microbial production of biofuels	13	28%
2	An overview of solid-state fermentation, Fermentation processes of Enzyme (Amylase, Protease) Fermentation processes of alcohol, organic acids (Gluconic acid / Citric acid) Fermentation processes of amino acids (Lysine), vitamins (Vit. B12) Fermentation processes of antibiotics (penicillin, Streptomycin) Fermentation processes of Microbial Biomass (SCP, SCO)	13	28%
3	CONTROL PARAMETERS & ECONOMICS Control systems manual and automatic, combined method, requirement for control, Recent trends in fermentation control Biosensors: Principles and definition, characteristics of Ideal biosensors, Basic measuring procedure, Biochemical components of biosensors: Enzyme based biocatalyst sensors, Bioaffinity systems, Immunosensors Application of Biosensors: Clinical laboratory, In vivo determination of metabolites, Environmental monitoring of toxic compound. Fermentation economics: Fermentation economics for isolation , strain improvement, media design, sterilization , aeration and agitation and effluent treatments Immobilization: Basic concept of immobilization in biotechnology, Principles and mechanism of Immobilization, Methods of Immobilization with examples	19	44%

Text books: Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.

Reference Books:

1. Patel AH. (1996). Industrial Microbiology .1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India

2. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction. 9th Edition. Pearson Education
3. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
4. Prescott, Harley and Klein's Microbiology. 9th Edition. McGraw Hill Higher education Adams MR and Moss MO. (1995).

List of Open Source Software/learning website:

- <https://www.youtube.com/watch?v=HNOcQKwW5ks>
- <https://archive.nptel.ac.in/courses/102/105/102105058/>

List of Experiments:

1. Bioassay of Penicillin using Bacillus subtilis.
2. Typical fermentation of alcohol,
3. Typical fermentation of gluconic acid.
4. Fermentative production of Amylase and determination of Amylase activity.
5. SCP (Single Cell Protein) production
6. SCO (Single Cell oil) production
7. Fermentative production of Citric acid and Citric acid estimation by titrometric method.
8. To perform gel entrapment of yeast cells and determination of invertase activity of immobilized yeast cells.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	To describe and Microbial processes for sustainable development	1 Remembering 2 Understanding
CLO2	To explain and discuss various Fermentation processes	1 Remembering 2 Understanding 3 Applying 4 Analyse
CLO3	To list types of Biosensors and understand its mechanism and structure, so the it will help to design	1 Remembering 2 Understanding 3 Applying 4 Analyse 5 Evaluate
CLO4	To be able discuss various methods of Immobilization and its commercial applications.	1 Remembering 2 Understanding 3 Applying
CLO5	To understand and study the control parameters & economics control systems in fermentation.	1 Remembering 2 Understanding 3 Applying
CLO6	To identify and understand Fermentation economics so as to evaluate and design cost effective processes	1 Remembering 2 Understanding 3 Applying 4 Analyse 5 Evaluate 6 Create

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	2	2	3	2	3	1	1	3	1	2	2	1	2	1	2	1	1	2	2
CLO2	2	1	3	2	1	3	3	3	2	2	3	1	1	2	1	2	3	2	3
CLO3	2	1	2	2	1	3	1	1	1	2	2	3	3	1	2	1	1	2	2
CLO4	2	3	3	2	1	2	1	2	1	2	2	2	2	1	1	2	3	1	3
CLO5	2	2	1	2	2	3	1	1	2	1	2	3	3	1	2	1	2	3	2
CLO6	1	3	1	1	2	3	1	2	1	2	1	2	3	2	1	1	2	1	1

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Biostatistics
Course Code:	16-MIE303-3C
Pre-requisite Course:	Basic Mathematics like probability, mean, median, etc.

Course Objectives:

- ☐ To understand collection, classification and presentation of data.
- ☐ To get an idea of importance of sampling and know various sampling method.
- ☐ To apply statistics on the data collected.
- ☐ To understand the importance of statistics in reaching to any conclusion.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	-	25	100

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	Introduction to Biostatistics Introduction to Biostatistics: Definition of statistics and biostatistics, Development of biostatistics, Applications and role of biostatistics Sources and Presentation of Data: Types of data and Collection of data, Classification and tabulation, Diagram and Graph, Frequency distributions of data. Variables and its types. Sampling: Introduction and Definition, Types of population, Sample, sampling variation and Bias, Listing of population and sample size	15	33%
2	Tools and Techniques for data-analysis Measures of central Tendency: Mean, Median and Mode, Position of averages, Selection of the appropriate measure of central Tendency, Geometric mean and Harmonic mean. Partition values: Quartiles, Deciles and Percentile Measure of dispersion: Standard deviation and standard error	15	33%
3	Correlation and Regression Hypothesis testing Chi-Square Test: The formula for Chi-Square Test, Distribution of Chi- Square Test and degree of freedom, Application of Chi-Square Test Student t-test: Introduction, Student's t-Distribution, Application of t- Distribution Analysis of Variance (ANOVA): Principle of ANOVA, Partitioning of ANOVA, Comparison of pairs of Means, Assumption Underlying ANOVA, Application of ANOVA	15	34%

Text books:

- A Textbook of Biostatistics and Research Methodology (2022) by Dr. Dattatraya M. Shinkar,, Dr. William Arputha Sundar, 1st Ed.

Reference Books:

- Goon A.M. Gupta M.K. and Dasgupta B. (1985): Fundamental of Statistics Vol. I The World Press Private Ltd. Calcutta.
- Elements of Biostatistics by Prasad (2018) 3rd ed.
- Fundamentals of Biostatistics by Bernard Rosner (2011), 7th ed.

List of Open-Source Software/learning website:

- <https://archive.nptel.ac.in/courses/102/101/102101056/>

- https://www.youtube.com/watch?v=2FdhaofDkKg&list=PLoNoar1DIEikWkiRSwtu2gzAS_NdHeVo&index=2
- <https://www.youtube.com/watch?v=0dRtFDlb2Wk>

List of Experiments:

- Problems Solving using Mean
- Problems Solving using Median
- Problems Solving using Mode
- Problems Solving using Harmonic Mean
- Problems Solving using Geometric Mean
- Problems Solving using Standard Deviation
- Problems Solving using Hypothesis
- Problems Solving using Chi square test
- Problems Solving using t-Test
- Problems Solving using Anova

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Learn the basics of data collection and presentation.	1 Remember
CLO2	Basically, understand the factors responsible sampling.	2 Understand 3 Apply
CLO3	Apply the measure of central tendency in taking decisions	3Apply
CLO4	Analyze the data for reaching to a conclusion.	4 Analyze
CLO5	Think critically about and applying various tool for data analysis	5 Evaluate
CLO6	The student would be able to create a new process by applying the biostatistics tool.	2 Understand 6 Create

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	2					3					2					3			
CLO2		1			2		1			3		1			2				
CLO3			3					2					2			2			
CLO4		2					2					2							
CLO5					2					2					2				
CLO6	1					1					1					2			

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Advanced English
Course Code:	16-AEC301-3C
Pre-requisite Course:	Basics English Grammar and Composition up to T.Y. B.Sc.

Course Objectives:

- ☐ To inculcate human values among the students through poems and prose.
- ☐ To create an interest in literature and to develop language skills.
- ☐ The students will become familiar with formal vocabulary that is common in academic texts.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
2	--	-	2	25	25	-	-	50

Subject Contents:

Unit	Topic	Total Hours	Weightage (%)
1	VOCABULARY&GRAMMARLINK Review of Confusing Words, Simple- Compound and Complex Sentences.	9	30
2	SPEAKING Group Discussion Group discussion as a part of selection process, group behavior & leadership Potential, Tips for Effective group discussion. Group Discussion (GD) Topics on Current Affairs The New Education Policy (NEP): Challenges in Implementation, India's Space Missions: From Chandrayaan to Gaganyaan, India's Role in G20 Leadership: Achievements and Challenges	6	20
3	READING&WRITING Writing Portion Essay Writing: Electric Vehicles: The Future of Transportation, The Role of Artificial Intelligence in Shaping the Future, Impact of Western Culture on Indian Youth, How Technology is Transforming Education Unseen Passages/Comprehension Texts from journals, newspapers, research articles, and essays.	6	20
4	TEXT Catalyst-Lesson 6 to 10	9	30

Text Books:

- Catalyst-Text Book,2020
- Easy to learn English grammar by Dr.Jayesh Patel,2021

Reference Books:

- Very Useful Verbs book (Enka Publication)2021
- Contemporary English Grammar Structure & Composition,2020
- Murphy R. Intermediate English Grammar(New Delhi: Cambridge University)2019

List of Open-Source Software/learning website:

- englishpage.com
- epaper.timesofindia.com
- epaperindianexpress.com
- <https://www.youtube.com/watch?v=QdAgyD4xhY>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Describe how public speaking can be used to advocate or create change	1 Remembering
CLO2	Explain the goals and benefits of public speaking	2 Understanding
CLO3	Use parallel structures correctly and effectively.	3 Applying
CLO4	Identify strategies for researching and supporting a speech	4 Analyzing
CLO5	Recognize when to use visual aids	3 Applying
CLO6	Describe how public speaking can be used to advocate or create change	6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1				3		1		2			1				1				
CLO2			2	3	2	1	2			2	1	2							
CLO3			1	2				2	1						2				
CLO4							1				1								
CLO5					1		1			2		1			1				
CLO6			1																

3: High, 2: Medium, 1: Low

Branch Name:	B.Sc. Biotechnology
Program Code:	SC101
Course Name:	Data Analysis for Biologist
Course Code:	16-MIE303-3O
Pre-requisite Course:	

Course Objectives:

- Understand and apply key concepts of probability, statistics, and linear algebra using R for biological data analysis.
- Develop skills in data visualization, regression, clustering, and classification techniques using R.
- Analyze and interpret complex biological datasets through advanced methods like PCA and t-SNE.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	--	2	4	50	25	--	25	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	Basic concepts of probability and statistics • Rules of probability • Discrete probability distribution • Continuous probability distribution • Statistics using R ,À Descriptive Statistics • Moments: variance and covariance • Linear Algebra using R • Concept of statistical tests • Basic concepts of linear algebra • Vector and vector operations • Matrix and matrix operations • Determinant and Inverse of a matrix • Eigenvalue and eigenvector • Linear system of equations • Singular value decomposition • Basics of R • Getting ready with R • Algebraic and logical operations in R • Reading and writing data • Statistics using R “ descriptive statistics • Statistics using R “ t-test and ANOVA • Linear algebra using R	15	34%
2	Data visualization • Histogram & Box plot • Heatmap and Volcano plot • Network visualization • Data visualization using ggplot2 – I • Data visualization using ggplot2 - II	15	33%

	• Correlation and regression - Correlations • Linear regression – I • Linear regression – II • Linear regression using R • Multiple linear regression • Multiple linear regression using R - Clustering and classification, Correlation and regression • Nonlinear regression • Nonlinear regression using R • Clustering and classification • Logistic regression • Logistic regression using R • Distance measures for clustering		
3	Clustering and classification • k-means clustering • k-means clustering using R • Hierarchical clustering • Hierarchical clustering using R • Decision tree classifier • Support vector machines Analysis of higher-dimensional data • Higher-dimensional data in biology • Principle component analysis • Principle component analysis using R • Statistics using R ,À Descriptive Statistics • t-SNE using R • Linear Algebra using R	15	33%

List of Experiments:

Practical Steps for Data Analysis in Biology:

1. Define the Research Question: Clearly state the biological question you want to answer with your data.
2. Data Collection and Preparation: Gather and organize the data, ensuring it's compatible with your chosen software.
3. Exploratory Data Analysis: Examine the data to understand its structure, identify trends, and spot outliers.
4. Statistical Analysis: Choose appropriate statistical methods (e.g., ANOVA, chi-square tests, regression) to analyze the data.
5. Interpretation and Conclusion: Interpret the results in the context of your research question and draw conclusions.

Reference Books:

1. Whitlock, Michael C.; Schluter, Dolph. The Analysis of Biological Data (2nd edition).Freeman, W. H. & Company, 2014.
2. Yang, Zheng R.; Machine Learning Approaches to Bioinformatics. World Scientific, 2010.
3. Moses, Alan; Statistical Modeling and Machine Learning for Molecular Biology. Chapman and Hall/CRC, 2016.
4. Hartvigsen, Gregg. A Primer in Biological Data Analysis and Visualization Using R, (1st Edition). Columbia University Press, 2014.
5. Stewart, James; Day, Troy; Biocalculus: Calculus for Life Sciences. Cengage Learning, 2015
6. James, Gareth, et al. An introduction to statistical learning with application in R. Vol. 112. NewYork: springer, 2013. First edition can be downloaded from the website <https://www.statlearning.com/>

List of Open-Source Software/learning website:

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Learn and explain fundamental concepts of probability, statistics, and linear algebra, and apply them using R programming.	1 Remember 2 Understand 3 Apply
CLO2	Perform descriptive statistical analysis and hypothesis testing (t-test, ANOVA) using R.	3 Apply 4 Analyze
CLO3	Develop and interpret various data visualizations including histograms, box plots, heatmaps, and network graphs in R.	3 Apply 4 Analyze
CLO4	Conduct correlation and regression analyses (linear, multiple, nonlinear, logistic) using R and interpret results.	3 Apply 4 Analyze
CLO5	Implement clustering and classification techniques such as k-means, hierarchical clustering, decision trees, and SVM.	3 Apply 4 Analyze
CLO6	Analyze and interpret high-dimensional biological data using advanced techniques such as PCA and t-SNE in R.	4 Analyze 5 Evaluate

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1	3	3	1		1					2							1	3	2
CLO2	3	3	2		2					2							1	2	2
CLO3	3	3	2		3					2							2	3	3
CLO4	3	3	1		3	1				2							1	1	2
CLO5	3	3	1		2	1				2							1	2	3
CLO6	3	3	3		3	1				2							3	3	3

3: High, 2: Medium, 1: Low