

**ST. XAVIER'S COLLEGE (AUTONOMOUS), AHMEDABAD-9
FACULTY OF SCIENCE**



DEPARTMENT OF BIOCHEMISTRY – BIOTECHNOLOGY

SEMESTER – IV SYLLABUS

OF

BSc BIOTECHNOLOGY (HONOURS)

**BASED ON UNDERGRADUATE CURRICULUM FRAMEWORK
(NEP – 2020)**

(Effective from Academic Year 2023)

Programme Outcomes

- PO1. Create a strong knowledge domain/ expertise
- PO2. Develop critical thinking, Problem solving and research aptitude
- PO3. Skill development
- PO4. Encouraging social interaction, service learning and develop equity centred national development (Social Extension work)
- PO5. Self-directed and lifelong learning
- PO6. Developing employability and entrepreneurial skills
- PO7. Promoting Ecological sustainability development
- PO8. Nurturing creativity and humane values

Programme Specific Outcome for BSc Biotechnology

- PSO1. Comprehensive and Procedural Knowledge: Discuss and interpret the basic concepts of all subjects under the aegis of current multidisciplinary Biotechnology to translate and apply the same for professional, entrepreneurial and societal benefits.
- PSO2. Skill development: Learn wide – ranging technical skills inclusive of digital learning skills through laboratory sessions/ research projects and develop self-directed experiential learning with an objective to associate biotechnology with improving life, industrial applications and environment.
- PSO3. Critical thinking, Creativity and Problem Solving: Develop competence to solve problems in familiar and non – familiar context especially to alleviate stress in all life forms, develop an analytical mind to use information from various sources and create plans/models to come up with innovations in the field of Biotechnology.
- PSO4. Communication and Collaboration: Ability to communicate the understanding of the learning to others confidently and precisely, interact with diverse multicultural groups working in the subject area as well as collaborate to achieve goals that have a wider outreach.
- PSO5. Leadership, Lifelong learning and ethics: Extend the applicability of Biotechnology to service learning and nation development through awareness programmes/ action - oriented projects in health, nutrition, and environment; be accountable, responsible and conscientious in leading roles both in profession and personal space.

Curriculum Framework for Semester – IV BSc (Hon.) Biotechnology

Course	Title	Content	Hours/ week	Credit
DSC-1 (Theory)	BT – 4501 Microbiology	Unit 1: Basic structure of microbes Unit 2: Microbial growth and nutrition Unit 3: Microbial Control Unit 4: Basic concepts of Soil and Water Microbiology	4 hrs	4
DSC-2 (Theory)	BT – 4502 Recombinant DNA Technology	Unit 1: Basic concepts and Tools in Molecular Biology Unit 2: Cloning Vectors and Identification of Clones Unit 3: Studying gene location and structure Unit 4: Gene expression and regulation	4 hrs	4
DSC-1 (Lab)	BT – 4503 Experiments in Biotechnology - I	2 Credits: Lab based on Microbiology and rDNA Technology 2 Credits: SWAYAM course on ANY ONE <ul style="list-style-type: none"> • Experimental Biochemistry (8 – 12 weeks) • Data analysis for biologists (8 weeks) • Introductory Mathematical Methods in Biology (8 weeks) 	8 hrs	4 (2 + 2)
Minor – I	BC – 4103 (Nutrition – II)	Theory (2 Credits) U – 1: Nutritional importance of basic biomolecules U – 2: Nutritional assessment and importance of vitamins and minerals Lab (2 Credits): Practicals based on Nutritional assessments	6 hrs	4 (2 + 2)
SEC	BT – 4650 Critical Thinking in Biotechnology	U-1: Fundamentals of Critical Thinking U-2: Applying Critical Thinking	2 hrs	2
AEC	Ability Enhancement Courses	(To be chosen from a Basket of Courses)		2
VAC	Value Added Courses	(To be offered by the concerned subject Department)		2
Total Credits				22

BSC. (HONS.) BIOTECHNOLOGY SYLLABUS

SEMESTER – IV

Major Discipline Course – 1: Microbiology

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
BT – 4501 Microbiology	4 (60 hr)	0	0	10 + 2 from a recognized board in any stream	Nil

I. Course Learning Objectives

Thus, the knowledge from this course can help in the following:

- The students could pursue a career in industries that specialize in synthesis of various chemical components like acetic acid, enzymes, antibiotics, drugs etc.
- The students can carry out basic research in Microbiology and Biotechnology, which in turn can be of great help in the commercialization of various microbial products.
- Students can also go in for Medical Laboratory Technique Courses, opening opportunities in hospitals and pathological laboratories.
- Basic knowledge of microbiology is required for Fermentation Technology which is a basic technology used in many Pharmaceutical and Biotech companies.
- Entrepreneurial start-ups for small scale industries like production of biofertilizers, fermented foods etc.

II. Course Learning Outcomes

The main objective of the course will be to understand the concepts of Microbiology

By the end of the paper, a student should be able to:

- CO 1: Correlate the morphology of a prokaryotic cell and the fine structure of its organelles with its functions
- CO 2: Differentiate between eubacteria, archaeobacteria, fungi, algae and viruses and comprehend their economic importance.
- CO 3: Understand the basic growth requirements and parameters of bacteria in order to culture them *in vitro* for research, industrial applications, beneficial products that can enhance quality of life.
- CO 4: Design methodologies to control the growth of microbes by various sterilization techniques and chemotherapeutic drugs. For example: Milk is pasteurized to ensure

- that its shelf life is long; keeping surgical tools and rooms free of pathogens etc.
- CO 5: Analyze the role of microbes as tools to minimise use of chemicals, improvise waste water treatment and decreasing environmental pollution by biodegradation.

III. Course Content

Unit 1: Basic structure of microbes (1 Credit)

Cell morphology and fine structure of bacteria; Size, shape and arrangement of bacteria; study of organelles: Structure, chemical composition and functions of – cell wall, cell membrane, flagella, mesosomes, fimbriae and pilli, capsules, ribosomes, intracellular inclusions and endospores. Identification of bacteria based on cell morphology and fine structure.

Salient features and economic importance of Archeobacteria, rickettsia, fungi, algae, and viruses

Unit 2: Microbial growth and nutrition (1 Credit)

Growth and Nutrition: Definition and calculation of generation time, Growth curve, diauxic growth curve. Measuring bacterial growth (SPC, serial dilution, direct microscopic count); Effect of various factors on growth and reproduction of bacteria: temperature, osmotic pressure, radiation, hydrostatic pressure, mechanical impact, surface tension (define types based on specific requirement e.g. thermophilic); Cultivation of anaerobes, pure culture isolation and preservation.

Nutritional requirements and broad categories of bacteria (auxotrophs, lithotrophs etc)

Preparation of media, Types of media (Natural, empirical, synthetic, defined, special media)

Unit 3: Microbial Control (1 Credit)

Control of microorganisms: Definition of terms: sterilization, disinfection, microbicidal, microbiostasis, sepsis and asepsis, antiseptic. Factors affecting; Sterilization and disinfection by physical means: moist, dry heat, radiations and filtration; Sterilization and disinfection by chemical means: characteristics of an ideal antimicrobial agent, phenol coefficient. Mode of action and uses of: halogen and halogen compounds, compounds of heavy metals, phenols and its derivatives, alcohol, detergents. Chemosterilant gases (formaldehyde, ethylene oxide, beta propiolactone); Chemotherapeutic agents: Mode of action, limitations and uses of: penicillin, streptomycin, tetracyclins, polymixins, choramphenicol, cephamines, sulfa drugs

Unit 4: Basic concepts of soil and water microbiology (1 Credit)

Microbiology of potable water: Coliforms as indicator of fecal contamination, Methods for differentiation of coliforms (IMViC, elevated temperature test), Bacteriological examination of drinking water (Standard plate count, Membrane filter technique, presumptive, confirmed, completed test, MPN test), Purification of drinking water (sedimentation, filtration and disinfection).

Soil Microbiology: Role of microbes in biogeochemical cycles (Carbon, Nitrogen, Sulfur, Iron, Phosphorous), Methods to study soil microbes (Direct microscopic method, agar plate technique, enrichment culture technique, buried slide technique)

IV. Recommended Learning Resources

1. Atlas R: Microbiology: Fundamentals and Applications (2nd ed)
2. Frobisher, Hinsdill, Crabtree, Goodheart: Fundamentals of Microbiology
3. Pelczar Reid: Microbiology (5th ed)
4. Prescott: General Microbiology 10th edition, 2017
5. Scheeler and Bianchi: Cell Biology
6. Stainer, Adelber, Ingraham: General Microbiology

V. Pedagogy

1. Classroom engagement through lectures and PowerPoints
2. Lecture videos and online resources
3. Workbooks/Group activities/Assignments/Class Tests

VI. Evaluation

The course paper is evaluated out of 100 marks, of which 50 percent weightage is of Internal Assessment and 50 percent weightage is of the End semester examination (External)

ASSESSMENT CRITERIA	INTERNAL EVALUATION	EXTERNAL EVALUATION
Continuous Internal Assessment (CIA) I and II	35	-
Assignment (Research element)*	10	-
Attendance	05	-
End Semester Exam	-	50
Total	50	50

**The assignment comprises writing a review of research articles with microbes and its applications as focal point/activity decided by the respective faculty member/s*

**ST. XAVIER'S COLLEGE (AUTONOMOUS), AHMEDABAD-9
FACULTY OF SCIENCE**



DEPARTMENT OF BIOCHEMISTRY – BIOTECHNOLOGY

SEMESTER – IV SYLLABUS

OF

BSc BIOTECHNOLOGY (HONOURS)

**BASED ON UNDERGRADUATE CURRICULUM FRAMEWORK
(NEP – 2020)**

(Effective from Academic Year 2023)

Programme Outcomes

- PO1. Create a strong knowledge domain/ expertise
- PO2. Develop critical thinking, Problem solving and research aptitude
- PO3. Skill development
- PO4. Encouraging social interaction, service learning and develop equity centred national development (Social Extension work)
- PO5. Self-directed and lifelong learning
- PO6. Developing employability and entrepreneurial skills
- PO7. Promoting Ecological sustainability development
- PO8. Nurturing creativity and humane values

Programme Specific Outcome for BSc Biotechnology

- PSO1. Comprehensive and Procedural Knowledge: Discuss and interpret the basic concepts of all subjects under the aegis of current multidisciplinary Biotechnology to translate and apply the same for professional, entrepreneurial and societal benefits.
- PSO2. Skill development: Learn wide – ranging technical skills inclusive of digital learning skills through laboratory sessions/ research projects and develop self-directed experiential learning with an objective to associate biotechnology with improving life, industrial applications and environment.
- PSO3. Critical thinking, Creativity and Problem Solving: Develop competence to solve problems in familiar and non – familiar context especially to alleviate stress in all life forms, develop an analytical mind to use information from various sources and create plans/models to come up with innovations in the field of Biotechnology.
- PSO4. Communication and Collaboration: Ability to communicate the understanding of the learning to others confidently and precisely, interact with diverse multicultural groups working in the subject area as well as collaborate to achieve goals that have a wider outreach.
- PSO5. Leadership, Lifelong learning and ethics: Extend the applicability of Biotechnology to service learning and nation development through awareness programmes/ action - oriented projects in health, nutrition, and environment; be accountable, responsible and conscientious in leading roles both in profession and personal space.

Curriculum Framework for Semester – IV BSc (Hon.) Biotechnology

Course	Title	Content	Hours/ week	Credit
DSC-1 (Theory)	BT – 4501 Microbiology	Unit 1: Basic structure of microbes Unit 2: Microbial growth and nutrition Unit 3: Microbial Control Unit 4: Basic concepts of Soil and Water Microbiology	4 hrs	4
DSC-2 (Theory)	BT – 4502 Recombinant DNA Technology	Unit 1: Basic concepts and Tools in Molecular Biology Unit 2: Cloning Vectors and Identification of Clones Unit 3: Studying gene location and structure Unit 4: Gene expression and regulation	4 hrs	4
DSC-1 (Lab)	BT – 4503 Experiments in Biotechnology	2 Credits: Lab based on Microbiology and rDNA Technology 2 Credits: SWAYAM course on ANY ONE <ul style="list-style-type: none"> • Experimental Biochemistry (8 – 12 weeks) • Data analysis for biologists (8 weeks) • Introductory Mathematical Methods in Biology (8 weeks) 	8 hrs	4 (2 + 2)
Minor – I	BC – 4103 (Nutrition – II)	Theory (2 Credits) U – 1: Nutritional importance of basic biomolecules U – 2: Nutritional assessment and importance of vitamins and minerals Lab (2 Credits): Practicals based on Nutritional assessments	6 hrs	4 (2 + 2)
SEC	BT – 4650 Critical Thinking in Biotechnology	U-1: Fundamentals of Critical Thinking U-2: Applying Critical Thinking	2 hrs	2
AEC	Ability Enhancement Courses	(To be chosen from a Basket of Courses)		2
VAC	Value Added Courses	(To be offered by the concerned subject Department)		2
Total Credits				22

BSC. (HONS.) BIOTECHNOLOGY SYLLABUS

SEMESTER – IV

Major Discipline Course – 2: Recombinant DNA Technology

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
BT – 4502 Recombinant DNA Technology	4 (60 hr)	0	0	10 + 2 from a recognized board in any stream	Nil

I. Course Learning Objectives

Thus, the knowledge from this course can help in the following:

- To chose a career in molecular biology and genetic engineering
- Exploit the basic understanding of the subject to create something that can help society
- Equip oneself with skills to grow in the biotech sector
- Work in biotechnology industries in Research and Development/Production/ Quality Assurance
- Carry out basic research in understanding many more molecular mechanisms inside a cell

II. Course Learning Outcomes

The main objective of the course will be to understand the importance of Genetic Engineering and its implications

By the end of the paper, a student should be able to:

- CO 1: Explore the basic tools, techniques and methods enabling designing of experiments for recombinant products to improve life.
- CO 2: Design gene constructs that can enable regulating gene expression
- CO 3: Evaluate and solve problems associated with recombinant DNA Technology
- CO 4: Explore feasible areas and sectors of its applications.
- CO 5: Evaluate the ethical issues associated with this field.

III. Course Content

Unit I: Basic Concepts and Tools of Gene cloning

What is gene cloning and why do we need to clone a gene?; Introduction to recombinant DNA technology: Introduction to vehicles of gene cloning, Handling of DNA, RNA, cDNA and Restriction enzymes, Laboratory requirements, Safety measures and regulations for rDNA work, Choice and selection of the tools and techniques; Purification of DNA from bacterial, plant and animal cells; Manipulation of purified DNA; Introduction of DNA into living cells; Different methods of horizontal gene transfer: Transformation, Conjugation and Transduction.

Unit II: Cloning Vectors and Identification of a clone

Vehicles: Plasmids, Bacteriophages and viruses, Phagemids and Cosmids; Bacterial Artificial Chromosomes; Vectors for yeast and other fungi: 2 μ plasmid, YEPs, YIPs, YRPs, and YACs; To obtain a clone of a specific gene: Direct selection, Selection using hybridization from Genomic DNA library, cDNA library; Probe designing and labeling; Identification of clones using alternative methods

Unit III: Studying gene location and structure

Gene location: Hybridization techniques – Southern blotting; In situ hybridization, FISH, OFAGE.

Studying gene structure; DNA sequencing: Sanger's method of chain termination and Maxam Gilbert's method of chemical degradation; Automated sequencing; Polymerase Chain Reaction and its types; Chemical synthesis of oligonucleotides.

Unit IV: Gene Expression and Regulation

Transcript analysis; Studying gene expression; Regulation of gene expression; Studying translated product of the gene; Studying protein – protein interactions; Expression vectors; Promoters used in expression vectors; Cassettes and gene fusions; Problems associated with production of recombinant protein in *E.coli*; Production of recombinant protein by eukaryotic cells like yeast and fungi; Study of protein functions by *in vitro* mutagenesis

IV. Recommended learning Resources

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York).
2. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell Publishing (Oxford, UK)
3. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S. B., and Twyman, R. M., Blackwell publishing (Oxford)
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC)

V. Pedagogy

1. Classroom engagement through lectures and PowerPoints
2. Lecture videos and online resources
3. Workbooks/Group activities/Assignments/Class Tests
4. Problem solving, and group projects. Assignments will be designed such that students inculcate the habit of reading reference books and science journals. The use of smart boards for teaching will also be promoted to enable more interaction based teaching.

VI. Evaluation

The course paper is evaluated out of 100 marks, of which 50 percent weightage is of Internal Assessment and 50 percent weightage is of the End semester examination (External)

ASSESSMENT CRITERIA	INTERNAL EVALUATION	EXTERNAL EVALUATION
Continuous Internal Assessment (CIA) I and II	35	-
Assignment (Research element)*	10	-
Attendance	05	-
End Semester Exam	-	50
Total	50	50

*The assignment comprises specific activities designed by the faculty members concerned.

**ST. XAVIER'S COLLEGE (AUTONOMOUS), AHMEDABAD-9
FACULTY OF SCIENCE**



DEPARTMENT OF BIOCHEMISTRY – BIOTECHNOLOGY

SEMESTER – IV SYLLABUS

OF

BSc BIOTECHNOLOGY (HONOURS)

**BASED ON UNDERGRADUATE CURRICULUM FRAMEWORK
(NEP – 2020)**

(Effective from Academic Year 2023)

Programme Outcomes

- PO1. Create a strong knowledge domain/ expertise
- PO2. Develop critical thinking, Problem solving and research aptitude
- PO3. Skill development
- PO4. Encouraging social interaction, service learning and develop equity centred national development (Social Extension work)
- PO5. Self-directed and lifelong learning
- PO6. Developing employability and entrepreneurial skills
- PO7. Promoting Ecological sustainability development
- PO8. Nurturing creativity and humane values

Programme Specific Outcome for BSc Biotechnology

- PSO1. Comprehensive and Procedural Knowledge: Discuss and interpret the basic concepts of all subjects under the aegis of current multidisciplinary Biotechnology to translate and apply the same for professional, entrepreneurial and societal benefits.
- PSO2. Skill development: Learn wide – ranging technical skills inclusive of digital learning skills through laboratory sessions/ research projects and develop self-directed experiential learning with an objective to associate biotechnology with improving life, industrial applications and environment.
- PSO3. Critical thinking, Creativity and Problem Solving: Develop competence to solve problems in familiar and non – familiar context especially to alleviate stress in all life forms, develop an analytical mind to use information from various sources and create plans/models to come up with innovations in the field of Biotechnology.
- PSO4. Communication and Collaboration: Ability to communicate the understanding of the learning to others confidently and precisely, interact with diverse multicultural groups working in the subject area as well as collaborate to achieve goals that have a wider outreach.
- PSO5. Leadership, Lifelong learning and ethics: Extend the applicability of Biotechnology to service learning and nation development through awareness programmes/ action - oriented projects in health, nutrition, and environment; be accountable, responsible and conscientious in leading roles both in profession and personal space.

Curriculum Framework for Semester – IV BSc (Hon.) Biotechnology

Course	Title	Content	Hours/ week	Credit
DSC-1 (Theory)	BT – 4501 Microbiology	Unit 1: Basic structure of microbes Unit 2: Microbial growth and nutrition Unit 3: Microbial Control Unit 4: Basic concepts of Soil and Water Microbiology	4 hrs	4
DSC-2 (Theory)	BT – 4502 Recombinant DNA Technology	Unit 1: Basic concepts and Tools in Molecular Biology Unit 2: Cloning Vectors and Identification of Clones Unit 3: Studying gene location and structure Unit 4: Gene expression and regulation	4 hrs	4
DSC-1 (Lab)	BT – 4503 Experiments in Biotechnology - I	2 Credits: Lab based on Microbiology and rDNA Technology 2 Credits: SWAYAM course on ANY ONE <ul style="list-style-type: none"> • Experimental Biochemistry (8 – 12 weeks) • Data analysis for biologists (8 weeks) • Introductory Mathematical Methods in Biology (8 weeks) 	8 hrs	4 (2 + 2)
Minor – I	BC – 4103 (Nutrition – II)	Theory (2 Credits) U – 1: Nutritional importance of basic biomolecules U – 2: Nutritional assessment and importance of vitamins and minerals Lab (2 Credits): Practicals based on Nutritional assessments	6 hrs	4 (2 + 2)
SEC	BT – 4650 Critical Thinking in Biotechnology	U-1: Fundamentals of Critical Thinking U-2: Applying Critical Thinking	2 hrs	2
AEC	Ability Enhancement Courses	(To be chosen from a Basket of Courses)		2
VAC	Value Added Courses	(To be offered by the concerned subject Department)		2
Total Credits				22

BSC. (HONS.) BIOTECHNOLOGY SYLLABUS

SEMESTER - IV

Major Discipline Course – 3: Experiments in Biotechnology - I

Course Title & Code	Credit Distribution of The Course			Eligibility Criteria	Prerequisite(s) of the Course (if any)
	Lecture	Tutorial	Practical / Practice		
BT – 4503: Experiments in Biotechnology - I	0	2 (SWAYAM Course)	2 (60 hr)	10 + 2 from a recognized board in any stream	Nil

I. Course Learning Objectives

The learning objectives of this paper is as follows:

- To be able to develop a skill set to handle and culture microbes, and basic molecular biology techniques
- Students should understand the principles, theory, protocol and calculations for each experiment and apply them for research or small projects.
- They should discern the importance of precision and accuracy in reagent preparations and designing of experiments.
- The analysis and interpretation of each laboratory experiment should be able to initiate logical thinking and accountability, especially if the samples being studied are related to clinical and nutritional studies.
- The skill set should enhance their knowledge and employability.

II. Course Learning Outcomes

The main objective of the course will be to build the basic foundation as well as skill in the subject of biochemistry.

By the end of the paper, a student should be able to:

- CO 1: To handle and isolate microbes; study their morphology and applications
- CO 2: To isolate DNA and RNA from different sources and analyse the isolated DNA
- CO 3: To understand the nuances of instruments and techniques to study microbes and DNA
- CO 4: To relate principles and protocols of the experiments
- CO 5: To plan experiments for applications

III. Course Content (Laboratory Experiments)

(2 Credits)

Basic techniques in Microbiology

1. Introduction to stains and staining procedures
2. Monochrome staining(Positive and negative)
3. Gram staining
4. Capsule staining
5. Metachromatic granules staining
6. Spore staining(optional)
7. Methylene blue reduction test
8. Antibiotic assay by agar cup method
9. Antibiotic assay by disc/ditch method
10. Most probable number test (MPN)
11. Isolation of Gram negative lactose fermenters and coliforms
12. Identification of microorganisms and Fermentation tests for microorganisms

Basic techniques in recombinant DNA technology

13. Genomic DNA isolation from bacteria
14. Plasmid DNA isolation
15. Assessment of quality and quantity of DNA
16. Agarose gel electrophoresis to visualize DNA
17. Restriction digestion
18. DNA ligation

B. Online course work on Experimental Biochemistry

(2 Credits)

The students are to choose from one of the below mentioned SWAYAM courses:

1. Experimental Biochemistry (8 – 12 weeks)
(https://onlinecourses.nptel.ac.in/noc22_cy32/preview)
2. Data analysis for biologists (8 weeks)
(https://onlinecourses.nptel.ac.in/noc22_bt20/preview)
3. Introductory Mathematical Methods in Biology (8 weeks)
(https://onlinecourses.nptel.ac.in/noc20_bt13/preview)

IV. Recommended Learning Resources

1. Plummer: An introduction to Practical Biochemistry, 1988, Tata Mc Graw- Hill education
2. Thomas and Schalkhammer: Analytical Biochemistry, 2002
3. Varley H: Practical Clinical Biochemistry, 1980, Heinemann, London
4. Wharton and McCarty: Experimental methods in Biochemistry; Macmillan, New York. Whistler, R. L. (1964)
5. Seeley HW and Van Denmark PJ: Microbes in Action

6. Wistreich GA and Lechman MD: Laboratory Exercise in Microbiology; 1973, Glencoe Press, New York, Beverly Hills
7. Sambrook J, Fritsch E F, Maniatis T: Molecular Cloning (A Laboratory Manual: 3 Volumes), 2nd Edition, 1989, Cold Spring Harbour Lab

V. Pedagogy

1. Explanation of each laboratory experiment emphasising on the use of different reagents and instruments
2. Problem solving, group activities and presentations. There are defined activities for every laboratory experiment in the journal, which encourages self-learning, peer learning, team work, developing presentation skills and reading from science articles and research papers.
3. Learning outcome based questions, which develops reading and writing skills and lab tests

VI. Evaluation

The course paper is evaluated out of 100 marks, of which 50 percent weightage is of Internal Assessment and 50 percent weightage is of the End semester examination (External)

ASSESSMENT CRITERIA	INTERNAL EVALUATION	EXTERNAL EVALUATION
Internal Practical Examination*	35	-
Assignment (Research element)**	10	-
Attendance	05	-
End Semester Practical Exam	-	50
Total	50	50

**The internal practical exam will entail the students to answer a question paper based on the experiments in their journal, to perform two experiments and give a viva voce (optional). The journal duly completed and signed will also carry weightage.*

***The assignment comprises group activities that need the students to review literature, collate and present the data or carry out a short project, collate, interpret and present the data either as an oral presentation or a poster presentation and/or a documented report.*

The SWAYAM course will be evaluated based on the assignments in the course work and an internal assessment.